HOUSEHOLD DEMAND FOR MEATS USING EXPENDITURE ALLOCATION MODELS

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2000

This dissertation is dedicated to my parents, Clara and Augusto Medina.

ACKNOWLEDGMENTS

I would like to express my deep appreciation and gratitude to Dr. Ronald Ward, chairman of the supervisory committee, for his valuable guidance, assistance and dedication throughout this research. His continuous advice, patience and orientation have been extremely important throughout my dissertation. His enthusiasm, organization and positive attitude gave me the confidence needed to bring this dissertation to a successful conclusion.

I would also like to express my thanks to the other committee members, Drs. Thomas Spreen, John VanSickle, Richard Weldon, from the Food and Resource Economics Department and Dr. Kenneth Portier from the Statistics Department. Special gratitude goes to Dr. Spreen and Dr. VanSickle for all their guidance in the initial part of my doctoral program.

I am also grateful to other faculty, staff, and fellows students in the Food and Resource Economics Department who helped making my experience in the U.S. a valuable one.

Special appreciation is extended to my parents, Clara and Augusto, for all their support and understanding, throughout my stay in the U.S. My family in Portugal and all my friends in Gainesville and around Europe were also responsible for making my stay an unforgettable one.

I would also like to acknowledge the financial support received from the Food and Resource Economics Department (FRE) and from Fundacao para a Ciencia e a Tecnologia, Portugal.

Finally, this dissertation is dedicated to my parents for all their support, unconditional love and the confidence they have in me.

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December, 2000

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Major Department: Food and Resource Economics

Within a two week period 95 percent of U.S. households purchase some quantity of beef, fish, pork or poultry, with annual expenditures accounting for 2.2 percent of the typical household income. A clear understanding of meat demand is important in the development of new product forms and to help the meat industry to be proactive in providing households with a reliable and safe source of protein. Beef, pork, poultry, and fish are substitutable goods and demand has changed over time and it is absolutely essential to measure those major factors relating to the demand for these meats. Understanding demographic differences and their impacts on purchasing decisions is the most fundamental aspect of demand analysis for an industry.

To empirically measure the demand for meats, one must further consider the various product forms where, for example, beef is consumed as steaks, roasts, ground beef, and others. Poultry may appear as chicken, turkey, or other types of poultry. Changes in these forms can be as important as the overall level of consumption of each of the four meat types.

Consumer household purchasing data are used with around 8000 households reporting one

or more times over the months from 1992 through 1998. Each household records both the quantity and expenditures on beef, fish, pork and poultry along with the detailed cuts within each meat type.

Drawing on established utility theory, demand functions for each of the meat types and forms are presented. These demands are estimated using various forms of expenditure allocation models where the expenditure shares are estimated showing their relationship to prices, demographics, demand enhancing variables, and total expenditures. Household consumption behavior is expected to be profoundly different across income groups and the estimation takes that difference into account. A standard output from these models includes the various price and expenditure elasticities. Along with the elasticities, all demand drivers are ranked in terms of their relative importance. Simulation analyses are used to show the impact of the different demographics on household demand for meat products.

The different demographics are separated from the other exogenous variables, namely the health and promotion ones, in order to show what is driving the demand for each meat product. The ranking of the different demographics will help industry analysts in planning different marketing strategies. Target markets can be identified and changes can be made by the industry to try to address negative effects.

CHAPTER 1
INTRODUCTION

Meat products have been important to the U.S. economy since the early Colonial days. After World War II, as Americans became more affluent, the demand for meats exploded. With the approval of the General Agreement on Tariffs and Trade in 1994, the meat industry has become increasingly global. Today, the U.S. meat industry is the largest component of both the nation's agricultural sector and food marketing industry, employing nearly half a million workers and contributing over $90 billion in annual sales to the Gross National Product (GNP). The meat industry is comprised of large multinational corporations, independent companies and small family owned businesses which together generate sales of more than $90 billion a year. It is spread throughout the nation and is a major employer of skilled and semi-skilled workers.

Consumer demand for meats has been increasing over the past years. According to the U.S. Department of Agriculture (USDA), consumers are eating about 1.5 extra pounds than they used to do. Factors that have helped meat demand include a strong U.S. economy, rising wages, low inflation and a low unemployment rate. Consumers are also recognizing the nutrient contributions of meat to diet quality. Meat plays an important role in a healthful diet by providing a bundle of nutrients, such as zinc, iron, protein and several B vitamins.

It is clear that the meat sector is an absolutely essential part of the U.S. food chain. Yet that does not mean that the industries within the meat sector are not subject to substantial changes both across consumers and over time. Especially since the 70s the four basic meat types (i.e., beef, poultry, pork, and fish) have experienced changes that profoundly influenced the underlying demand

for meats. Technological changes in the product development, preparations, storage, and delivery have essentially provided consumers with a much larger set of alternatives. Some sectors such as the poultry industry have probably been more innovative in terms of product development. One can simply look at the variety of prepackaged poultry products compared to beef or fish and see the difference. Part of that change may be due to the nature of the product, yet part must be attributed to the aggressiveness of that particular industry. Similarly product packaging and labeling are essential in that they not only preserve the product, but they play an important role in consumers' buying decisions. There is little question that the packaging and presentation influence the perceptions about a product and, ultimately, the purchasing decision.

Innovation extends beyond product development and this is particularly true within the meat sectors. Growth of food consumption away from home has become a major trend in the last three decades and is closely tied to the meat industries. Most fast foods and many restaurants are identified with meat products and particularly beef, fish and poultry. Simply look at the McDonald's, Fish-n-Chips, or Kentucky Fried Chicken franchises, each built around mostly one type of meat product with the consumer being able to easily identify the meat with the outlet. Pork's difficulty in establishing a ready identity among these types of franchises is clearly evident. Away from home food consumption probably influences our in-home buying habits as well.

There is probably no food sector that has been more profoundly influenced by food safety issues. The advent of BSE in Europe and other health related food problems have a profound impact on our consumption habits or, at least, our decision making process. Health issues occur throughout the food chain from slaughter to final preparation. While the U.S. meat inspection and packaging are among the best in the world, almost on a daily basis there are news articles about some health or sanitation issue related to one or more of the meat products. Such news can influence buying behavior as Verbeke, Ward and Viaene (2000) have shown for the Belgium meat markets.

Another dimension that must influence how the various meat industries address their particular health and product variety issues is closely tied to the underlying structure of the industries. Generally beyond the farm gate, the poultry industry is much more concentrated compared to the other three and that has probably been a major factor in terms of product innovation and control. Poultry has major brands that lend the industry to do more brand type promotions and related marketing activities. One can simply compare the brands for poultry to beef in any food chain and see the fundamental differences.

Buying behavior extends beyond having a set of alternatives and making the selections. Consumers have purchasing habits and those habits are partially a product of their information sets. Brands readily lend themselves to promotions and product identity as seen with the poultry sector. One can simply look at the Butterball Turkey brand as a good example. Recognizing the limited role of brands and commonalities within some industries and the need to provide consumers with information, both the beef and pork sectors have been proactive in developing an alternative method for communicating with consumers. Specifically, both the beef and pork industries have active national generic promotion programs that are funded by the producers in each industry. These programs focus on the attributes and use of these meats with the ultimate purpose of influencing the demand for each meat type.

Many of the considerations above can be influenced by the various meat sectors. Yet there exists a wide range of characteristics that cannot be changed. Purchasing habits differ across demographics and there is little that can be done about demographic changes. That is, the demographics are exogenous to the industry. Yet some aspects of the purchasing habits along demographics may be subject to change. Demographics such as aging, family size, education, employment, and location, among other factors, influence what consumers buy, including the meats. Understanding demographic differences and their impacts on purchasing decisions is the most

fundamental aspect of demand analysis for an industry. This is true because consumers are almost always targeted according to demographics. Hence, one must know how buying behavior changes along demographic lines and how important the demographics are relative to other factors influencing demand. As an example, if education level is the major factor causing consumers to buy less beef, then that sector would have a clearly targeted demographic for generating change, assuming such change is possible.

Over the last decades, there have been substantial shifts in consumption from red to white meat with a decrease in the demand for beef relative to pork and poultry. This decrease in demand has been attributed to several factors, including the relative price of poultry, changing consumer eating trends and overall health concerns. Numerous surveys have shown consumers to be concerned with fat and cholesterol, as well as with quality and consistency. Changing lifestyles are causing consumers to demand more convenient and healthier foods. This is particularly relevant for industry participants and government policy makers, calling possibly for a quality adjustment in production and increased efforts in promotion and marketing.

While the above discussion is general and, clearly, could be expanded into a thesis on each topic, what is clear is that understanding the demand for these products is the most fundamental aspect to what has and will happen to each meat sector. It is nearly impossible to know and measure everything that influences the demand for a given product. Equally it is probably not necessary to have a measure of every factor since some decisions are random and maybe of minor importance. Beef, pork, poultry, and fish are substitutable goods and demand has changed over time and it is absolutely essential to measure those major factors relating to the demand for these meats. There have been many demand studies of these products and much is known. Given both the innovation and changing demographics, clearly much is also not known about the demand for meats. Furthermore, how the demand is measured is equally important and that measure is closely tied to the data sources

used. The best way to quantify demand is to have information about consumer purchasing decisions. Most often such information has been aggregated in some way or is incomplete. Alternatively, if a time series of information over actual consumers was available, then a much closer look at the demand for beef, poultry, pork and fish could be completed, and hence the topic of this dissertation. As will be set forth later in this introductory chapter, a large data set of consumers recording their meat purchasing over several years is available. Using this data set, there is a unique opportunity to gain significant insight into the demand for each meat. Even with this rich database, one still must recognize that many things still cannot be measured such as quality variation, packaging, labeling, and variety. But with these data, new computer power, and relatively new econometric methods one can have a much more definitive picture of demand for beef, poultry, pork and fish. The main issue in this dissertation is to empirically measure the demand for different meat products building on previous research and applying new techniques and data.

Several studies have shown the importance of health and nutritional factors in consumer demand for meats. Capps and Schmitz (1991) concluded that health and nutrition factors, including cholesterol and fat content, should be taken into account in food demand studies. Moon and Ward (1999) specified an empirical meat demand model incorporating health concerns and demographic variables in which the existence of linkages between health concerns and meat consumption was shown. Verbeke et al. (2000) also analyzed the potential impact from mass media coverage and demographic consumer characteristics on decision making towards fresh meat. The main issue in most of these studies was to empirically measure the demand for different meat products.

In this dissertation the interest is in measuring the impact of major factors, such as demographic variables, prices, promotional effects, and health concerns on consumer preferences for meat, using a richer data set than was available for most previous studies.

Problem Statement

Within a two week period 95 percent of U.S. households purchase some quantity of beef, fish, pork or poultry, with annual expenditures accounting for 2.2 percent of the typical household income. A clear understanding of meat demand is important in the development of new product forms and to help the meat industry to be proactive in providing households with a reliable and safe source of protein. Product variety, quality, and safety along with relative pricing and information are important factors expected to continue to have a profound impact on what is consumed in the next several decades. Demand for meats has experienced major changes throughout the world, especially when viewed from a food safety perspective. Different demographics and prices can have an impact on demand for meats. A major management challenge for this food sector is to provide meat products consistent with these differing demands. One must have an empirical understanding of the demand for each meat type, its various cuts, and the nature of consumers' willingness to make substitutions among the types of meat.

To empirically measure the demand for meats, one must further consider the various product forms where, for example, beef is consumed as steaks, roasts, ground beef, and others. Poultry may appear as chicken, turkey, or other types of poultry. Changes in these forms can be as important as the overall level of consumption of each of the four meat types. Consumers make decisions according to consumption habits, prices, and other factors with the decision directed to the meat cuts and not just the meat type such as beef.

Research Objectives

Given the above problem, the objectives of this paper are:

1. To describe the data base used.
2. To develop econometric models for measuring meat demand using consumer household data.
3. To provide estimates showing the impact of the major factors influencing consumers' purchasing behavior when buying competing meat products.
4. To show the relative importance of the major demand factors, separating pricing considerations from demographic and other variables.
5. To show the management implications associated with having the empirical results.
6. To use the models for policy considerations.

Research Hypotheses

1. Consumers are willing to make substitutions among different types of meat such as beef, fish, poultry and pork. Within the various product forms, when looking, at for example, beef, consumers are willing to make substitutions among roasts, steaks, ground beef and other types of beef. For poultry, the choices are between chicken, turkey, and other types of poultry.
2. Frequency of the households reporting across the time of the survey makes a difference in the measurement of household expenditures for the different types of meat and product forms.

3. In addition to relative prices of the different meat products, factors such as demographics and seasonality influence the allocation of consumer expenditure shares among the different meat types and product forms.
4. Health concerns have an impact on consumer demand for the different types of meat. Specifically there is a negative correlation between cholesterol concerns and beef demand.
5. Promotions have a positive and statistically significant impact on the consumption levels.

Research Methodology

Drawing on established utility theory, demand functions for each of the meat types and forms are presented. The four different types of meat considered in this study are beef, fish, poultry and pork. Various product forms of the different meat types are also included in this analysis. For example, beef may be consumed as steaks, roasts, ground beef, and others, while poultry may appear in the form of chicken, turkey, and other types of poultry. Pork and fish are not sub grouped. A panel data consisting of time series observations on each of several cross sectional units is probably the best way to measure demand. In our study there is a panel data set with information on household demographics and the quantities and expenditures of the different households on various types of meat products. Meat demands are estimated using various forms of expenditure allocation models where the expenditure shares are estimated and their relationship to prices, demographics, demand enhancing variables, and total expenditures is shown separately for four income groups. A standard output from these models includes the various price and expenditure elasticities. In order to show what is driving the demand for each meat product and the direction of change, the different demographics will be ranked in terms of their relative effects on demand. Several policy implications will be set forth using simulation procedures. This provides a ready tool for predicting change and

identifying where markets should be targets if an industry wants to be proactive in influencing demand. Once the expenditure allocation models are estimated, the resulting equations are used to show why demands for different meats and cuts have changed. Finally, time will be spent in analyzing the effects of different demographics across income groups and meat types.

Data and Scope

Data used in this analysis are based on household panel reports collected by the National Panel Diary Group company (NPD, 1998). NPD is an independent company specializing in sampling and collection of panel data on consumer attitudes, demographics and consumption practices, and they spend considerable effort in making sure the panels are demographically representative of U.S. households. NPD sends every month a questionnaire to those households included in the demographically representative panel. The company maintains the household panel in which participating households keep eating diaries, documenting their purchasing habits for a designated time. An individual head of the household is assumed to be the female who reports the eating occasions within the home, recording the types of meat products consumed. Specifically, households report the quantities and expenditures of each meat product consumed along with the detailed cuts within each meat type purchased in a two-week time period. Beef purchases are grouped into four subcategories: roasts, steaks, ground beef, and other beef products while poultry can be consumed as chicken, turkey, and other poultry products. Fish and pork are not subdivided. One must recognize potential truncation problems when households do not consume a particular meat type or cut. Some households may simply not consume beef in a period and the expenditure share on beef would be zero. Appropriate procedures are available for dealing with this zero issue in research. When households are no longer representative of U.S. population, they are excluded from the panel. A two

week reporting time period is designated as a wave that is a numerical code corresponding to a month and year. Households may not consistently report each time period and issues related with this are also taken into account.

Prices can be determined from the expenditures and quantities of each meat type purchased. Data on most demographics are readily available for the monthly database extending from the last quarter of 1992 through the first quarter of 1998. Demographics are measured with income levels, household sizes, ages of females, presence of children in the household, female employment status, female education levels, geographic regions (by state) and market sizes. The full data set includes information on household demographics and the quantities and expenditures of the different households on beef, fish, poultry and pork for a total of 570,229 observations. Specific cuts or categories of the meats are also recorded. Information on household concern for health issues, such as fat and cholesterol, is also available from NPD. In addition, data on beef, poultry and pork promotion and advertizing expenditures for the same periods are available. Before the final estimation, the data are arranged by household and quarter with each household entry showing the purchases of each type of meat in a quarter. The final number of time series and cross sectional units gives a total of 37,866 observations. This aggregation by quarter makes sense as some of the data used in this study, (i.e., promotion, advertising and health) were reported on a quarterly basis.

The scope of this study is limited to household consumption of meat in the U.S. The data were provided by the National Panel Diary Group. The data are available monthly from the last quarter of 1992 through the first quarter of 1998 and include four different types of meat products: beef, fish, poultry and pork and numerous subcategories. The data are also limited by the definition of what is purchased by consumers, with no information available on quality and packaging of the different meat types.

Importance of the Study

Having a precise empirical measure of what is driving consumer purchasing decisions is fundamental to make long term risk management decisions. If most consumption decisions are based on relative prices then that calls for particular types of management and pricing strategies. If health concerns, demographic differences, promotions, and/or food safety are more important, then other management decisions are required. After ranking the impacts of all demand drivers, implications are drawn relative to those factors that can be influenced, such as promotions, versus those that are totally exogenous to the meat sector.

Managers must be prepared to respond to exogenous demand changes, yet be proactive when they can influence demand. These empirical models provide the bases for understanding the consequences from exogenous changes in meat demand while recognizing the potential where behavior can be influenced.

Overview

The second chapter of this study contains a review of literature on consumer demand theory, including demand analysis, various types of empirical demand systems, scaling and translating issues. The linkage between the utility theory and demand is shown and the concept of expenditure allocation models is explicitly developed. The Rotterdam Model, the Translog Model and the Almost Ideal Demand System (AIDS) model are set forth as examples of expenditure allocation specifications. The properties of the different models and the estimation procedures are specified Some of the empirical issues associated with the specific function of the AIDS model are also presented. Chapter 3 describes the data used in the analysis and includes some consumer statistics. Chapter 4 presents

the model development and the different estimation procedures. Econometric estimates of the different models are presented and discussed in Chapter 5. Chapter 6 concentrates on the estimated demand and market share elasticities and their interpretation in the context of the objectives of this study. Simulation analysis of changes in the relative prices and total expenditures on the different meat types and their impact on relative market shares are also presented. Chapter 7 deals with policy implications and simulations. It includes simulation analysis with respect to the impact of different demographics on household demand for meat products. Chapter 8 includes an overall discussion and the main conclusions of this study.

CHAPTER 2
LITERATURE REVIEW

U.S. consumer demand for meats is important for a number of reasons. Economists contend that a major reason why meat consumption is increasing is because it has become very affordable with beef, pork, poultry and fish expenditures accounting for only 2.2 percent of the average income. This value is almost 50 percent less than 25 years ago when consumers were spending 4.3 percent of their income in meat products.

According to U.S. Department of Agriculture (USDA) and private statistics, 99 percent of Americans eat meat and 94 percent eat red meat at some point. In fact, contrary to popular opinion, consumers are eating more meat. Total per capita consumption of beef, pork, poultry and fish increased by 16 pounds over the past decade with the average person increasing his or her total meat consumption by more than 1.5 pounds a year since 1985 (American Meat Institute, 1999). A clear understanding of meat demand is essential for the development of new product forms and for the meat industry to become more proactive in providing American households with reliable and safe sources of protein.

Demand for meats has been studied for decades and considerable progress is seen in the literature. As the literature on meat demand is reviewed in this chapter three dimensions in the evolution of studies stand out. First, and probably most important, considerable advancements have been made in the collection of data about household consumption patterns and behavior. Second, new and innovative estimation techniques are available to better understand demand. Third, product forms and issues relating to the characteristics of what is being consumed have moved to the forefront

among consumers' concerns. As will be seen throughout this research each of these dimensions to measure meat demand will be dealt with. At this point with Chapter 2, a review of some of the more important papers dealing with meat demand is set forth. Core to all the analyses is demand theory; hence this theory is the initial focus, followed with empirical studies.

Consumer Demand Theory

This part of the literature review is divided into three sections. First, demand analysis will be presented including the consumer's utility function and different demand conditions. Second, the specification of the various empirical demand systems is set forth, including alternative functional forms implied for the utility function. Third, the impact of different factors, such as demographics, on consumers' behavior will be evaluated using scaling and translating techniques.

Demand Analysis

A consumer's utility function represents his or her preference ordering among different bundles of goods. It is interpreted as the measurement of the level of satisfaction an individual experiences as a result of consuming a particular bundle of goods and services or commodities. The consumer allocation problem to determine what to consume can be formulated in a utility maximization framework. The quantities purchased by a consumer are theoretically the optimal quantities, i.e., the quantities determined by maximizing the utility function (U) subject to a given budget constraint.

(2.1) $$\text{Max } U = f(x_1, \ldots, x_n)$$

$$\text{St.} \sum_{i=1}^{n} p_i x_i = m$$

where p_i represents the price of the i^{th} good and *m* designates total expenditures on the n goods or income allocated to this set of separable goods. This maximization carried out by the Lagrangian method under plausible conditions on the utility function, yields the system:

(2.2 a) $$x_i = f_i(p, m) \qquad i=1, 2, \ldots, n; \text{ and}$$

(2.2 b) $$\lambda = \lambda\,(p,m)$$

The function that relates p and *m* to the consumer's demanded bundle (x_i) is called the consumer's demand function which describes the behavior of the consumer in the market. It describes how the consumer will behave when confronted with alternative sets of prices and a particular income. The Lagrangian multiplier, λ, is interpreted as the marginal utility of income. Both first and second-order conditions must be satisfied to assure that a maximum is actually reached. A demand system is defined for a given preference ordering. When preferences change, the demand system also changes as the form of the given utility function determines the form of the demand function.

A demand function of a single consumer is a relationship between the amount of a good the consumer is willing to buy given a budget limitation and the prices of all goods consumed. The Marshallian or uncompensated demand functions are obtained by solving the first order conditions of (2.1) for the quantities. When prices increase, real income actually declines and the term uncompensated simply means that the measured price effect includes both price and income components. Compensation then implies that the demand is estimated after adjusting income to bring real income back to the level before the price change. This system of demand functions or the demand for good *i* among *n* goods can be specified as:

(2.3) $$x_i = f_i(p_1, \ldots\ldots\ldots\ldots\ldots, p_n, m) \qquad i=1, 2, \ldots\ldots, n$$

where x_i = quantity of good *i*

p_i = price of the i^{th} good

n = number of goods

m = expenditures in the n goods

One of the properties of demand functions is that they do not exhibit money illusion. That is, a consumer faces money illusion if an increase in income causes an increase in purchases regardless of the prices of the goods. A demand function can be described by its elasticity values where demand elasticity is a measure of the relative responsiveness of the quantity purchased to changes in prices of the i goods or changes in income. The most common elasticities are own-price, cross-price, and budget (income) elasticities. For a given demand function $x_i = f_i(p, m)$, these elasticities can be defined as:

(2.4) $$\varepsilon_{ii} = (\partial x_i / \partial p_i)(p_i / x_i) \qquad \text{own-price elasticity}$$

(2.5) $$\varepsilon_{ij} = (\partial x_i / \partial p_j)(p_j / x_i) \qquad \text{cross-price elasticity}$$

(2.6) $$\eta_{im} = (\partial x_i / \partial m)(m / x_i) \qquad \text{budget (income) elasticity}$$

Own- price elasticities of demand measure the responsiveness of the demand for x_i to changes in the price of the same good, while cross - price elasticities measure the responsiveness of the demand for x_i to changes in the price of other goods. Two goods are said to be substitutes if the consumer can choose between them to meet certain needs; they are complements if they are jointly consumed in order to satisfy some particular need. Then x_i and x_j are substitutes if $\epsilon_{ij} > 0$ and complements if $\epsilon_{ij} < 0$. If $\eta_{im} < 0$, x_i is said to be an inferior good where an increase in the budget

reduces the demand for good i. Goods for which more income means more demand are called normal goods. Necessities goods are those for which $\eta_{im} < 1$, so that the marginal propensity to spend is less than the average propensity to spend, while luxuries goods are those for which $\eta_{im} > 1$.

The theory of duality and its application to consumer theory was first introduced by Hotelling (1932) and later by Samuelson (1952) and Shephard (1953). In recent years duality theory has become popular and is used in many branches of economics. For instance, it can be used as an alternative approach for obtaining the Marshallian demand system. The consumer's problem of maximizing utility for a given budget or cost can be reformulated as one of selecting goods to minimize the budget necessary to reach a certain level of utility:

(2.7) $$\min m = \sum_{j=1}^{n} p_j x_j$$

$$\text{St. } U = f(x_1, ..., x_n)$$

In the dual problem, being the determining variables u and p and not m and p, the same solutions of the primal problem are obtained but as a function of u and p. The new cost minimizing demand functions, h(u,p), are known as Hicksian or compensated demand functions. They are obtained by minimizing the consumer's expenditures subject to the constraint that the utility is at a fixed level U. Solutions to the primal and dual are the same; hence 2.8 holds:

(2.8) $$x_i = f_i(m, p) = h_i(U, p)$$

Each of these solutions can be substituted back into their respective problems to give maximum attainable utility and minimum attainable cost. Hence,

(2.9) $$U = g(x) = g(f(m, p)) = \phi(m, p)$$

(2.10) $$m = \sum p_i x_i = \sum p_i h_i(U, p) = c(U, p)$$

The function $\phi(m,p)$ defined by (2.9) is known as the indirect utility function and it represents the maximum attainable utility given prices p and budget m. The function c(U,p) defined by (2.10) is the minimum cost of attaining U at prices p and is known as the cost or expenditure function. The indirect utility function and the expenditure function are intimately related, representing alternative ways to get to the demand function.

Now consider the effect of a change of an exogenous variable such as price on the solution values for the endogenous variables, namely quantities. Changes in price and income will normally affect the consumers' expenditure pattern. A change in the price of a good changes the consumers' level of satisfaction since a new equilibrium on a new indifference curve is established. The substitution effect is that part of the variation in quantity demanded that is due to the fact that if the price of one good changes, its relative price also changes. As a result, less will be consumed of the good whose relative price increases. The income effect corresponds to the income compensation that was taken away in the substitution effect, leaving the consumer on the initial indifference curve. Algebraically the effect of a change in the price of a good on its own quantity demanded or on the quantity demanded of another good can be defined as:

$$(2.11) \qquad \frac{\partial x_j(p,m)}{\partial p_i} = \frac{\partial h_j(p,\phi(p,m))}{\partial p_i} - \frac{\partial x_j(p,m)}{\partial m} x_i(p,m)$$

The two terms on the right hand side are the substitution and income effects respectively. Equation (2.11) can be rewritten as:

$$(2.12) \qquad \frac{\partial x_j(p,m)}{\partial p_i} = \frac{\partial h_j(p,U)}{\partial p_i} - \frac{\partial x_j(p,m)}{\partial m} x_i$$

Equation (2.12) is known as the Slutsky equation which decomposes the demand change induced by a price change Δp_i into two separate effects: the substitution effect and the income effect.

The restrictions on the demand parameters can be derived from the properties of the utility function and the linear budget constraint. Specifically, they are developed by considering the

consequences of parametric shifts in the first-order conditions with respect to prices and income. A system of Marshallian demand functions, derived from the maximization of a specific utility function under a linear budget constraint, satisfies some restrictions, namely Engel aggregation or adding-up, Cournot aggregation, homogeneity of degree zero, negativity and symmetry.

Engel aggregation or adding-up

The adding up restriction follows from the budget constraint and the monotonicity assumption of preferences and it implies that the budget is totally used. Consumers' preferences are assumed to be strongly monotonic, when the consumer is assumed to prefer more to less of all goods. Demand equations have to be such that the sum of the estimated or predicted expenditures on the different commodities equals total expenditures. The substitution of the Marshallian demand functions into the budget constraint of (2.1) leads to

(2.13) $$m \equiv \sum_i p_i f_i(p_1,\ldots\ldots\ldots\ldots, p_n, m)$$

Differentiating (2.13) with respect to m and defining the average budget share for the i^{th} commodity as $w_i = p_i x_i/m$ and knowing that η_{im} is the income elasticity, the Engel aggregation is obtained:

(2.14) $$\sum_i w_i \eta_{im} = 1$$

The Engel aggregation condition states that the sum of the weighted income elasticities adds to unity.

Cournot aggregation

The Cournot aggregation condition expresses the weighted sum of the price elasticities as the negative of the expenditure proportion of the j^{th} commodity. It can be obtained by differentiating (2.13) with respect to p_j. Taking into account the definition of the cross price elasticity previously presented, the Cournot aggregation is obtained:

(2.15) $$\sum_i w_i \varepsilon_{ij} = -w_j \qquad \text{, for } j = 1, \ldots\ldots, n$$

Homogeneity of degree zero

Every demand equation ought to be homogeneous of degree zero in prices and income. If all prices and income are multiplied by a positive constant, *k*, the quantity demanded should remain unchanged and neither the budget constraint nor the utility function changes. Consumers do not suffer from money illusion, since decisions on the purchases among the goods are made on the basis of relative prices and income. Using Euler's theorem on the demand functions (2.3), the homogeneous of degree zero property is obtained in elasticity form:

(2.16) $$\sum_j \varepsilon_{ij} + \eta_{im} = 0 \qquad \text{for } i=1,\ldots\ldots, n.$$

The sum of the price elasticity for good i equals the negative of the income elasticity with the restriction holding for either a single demand equation or a complete demand system.

Negativity

Negativity represents another property of the demand functions which states that the matrix of substitution terms is negative semi-definite. This comes from the strict quasi concavity assumption for the utility function. The necessary condition for negativity can be formulated in elasticity form using the Slutsky equation (2.12). Being the expenditure function concave in prices, the substitution matrix is negative semidefinite, which is the negativity condition. Setting i = j, and multiplying (2.12) by (p_i/x_i) leads to:

(2.17) $$\varepsilon_{ii} + w_i \eta_{im} \leq 0$$

Symmetry

The symmetry condition states that the matrix of compensated cross price substitution effect is symmetric. This comes from the continuity and differentiability assumptions of the utility function. Young's theorem (Chiang, 1984) states that the substitution matrix is symmetric:

(2.18) $$\partial x_j / \partial p_i = \partial x_i / \partial p_j$$

Replacing (2.18) in (2.12) and rearranging terms in elasticity form gives:

(2.19) $$\varepsilon_{ij} = \frac{w_j}{w_i}\varepsilon_{ji} + w_j(\eta_{im} - \eta_{jm})$$

Empirical Demand Systems

Various empirical demand systems, with alternative specifications and functional forms implied for the utility function, have appeared in the literature since Richard Stone (1954) first estimated a system of demand equations explicitly derived from consumer theory. Market share changes among different types of meat and cuts can be evaluated using one or more of the share models based on expenditure allocation. The different types of expenditure allocation models: Linear Expenditure System (Stone, 1954), Rotterdam Model (Theil, 1965; Barten, 1969), Translog Model (Christensen, Jorgenson, and Lau, 1975), and Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer, 1980) can be used to estimate demand for consumption goods. These models have been extensively estimated and used to test homogeneity and symmetry restrictions on demand theory. Among these four different demand models, the AIDS is the most practical to be used. In the different models that will be presented the symbol notation does not carry over from equation to equation, it just illustrates the model being developed.

Linear expenditure system (LES)

The Linear Expenditure System was first estimated and proposed by (Stone, 1954) and represents the first formal treatment of demand analysis using a specific utility function. Expenditures on each good are linear functions of all prices and expenditures (Klein and Rubin, 1947-1948). Samuelson (1947-1948) showed that the LES could be derived from the Stone Geary utility function:

$$(2.20) \quad U(x) = \sum_{i=1}^{n} \beta_i \ln(x_i - \gamma_i), \qquad \beta_i > 0, \qquad (x_i - \gamma_i) > 0, \qquad \sum_{i=1}^{n} \beta_i = 1$$

where x_i represents the quantity of good i, n the number of goods and β_i and γ_i parameters. x_i is greater than γ_i and γ_i is the minimum amount of the i^{th} good that is consumed. Restrictions on the utility function guarantee that the demand system satisfies adding up and symmetry. Maximizing the utility function (2.20) subject to the budget constraint:

$$(2.21) \qquad \sum_{i=1}^{n} p_i x_i = m$$

yields the demand equations of the system:

$$(2.22) \qquad x_i = \gamma_i + (\beta_i / p_i)(m - \sum_{j=1}^{n} p_j \gamma_j)$$

Thus, the expenditure function which constitutes Stone's LES is:

$$(2\text{-}23a) \qquad p_i x_i = p_i \gamma_i + \beta_i (m - \sum_{j=1}^{n} p_j \gamma_j)$$

where p's denote prices and *m* the total expenditure on the n goods. In order for the Hessian to be negative definite, the β_i's have to be restricted so that $0<\beta_i<1$ for all i. Note that β_i is in fact the i^{th} marginal budget share, $\beta_i = \partial p_i x_i / \partial m$. For Samuelson, the expenditure on good i, $p_i x_i$, is decomposed in two parts. The minimum expenditure for the consumer to maintain a level of subsistence is $p_i \gamma_i$, with γ_i being the minimum required quantity the consumer first purchases. At given prices, $\sum p_j \gamma_j$ measures subsistence income, so that $(m - \sum p_j \gamma_j)$ is the supernumerary income, which the consumer

allocates among the n commodities in the proportions β_i's which are the marginal budget shares. Dividing through by *m*, the 2-23a can be expressed in expenditure shares spent on good i:

$$\text{(2-23b)} \qquad \frac{p_i x_i}{m} = \frac{p_i \gamma_i}{m} + \beta_i \left(1 - \frac{\Sigma p_j \gamma_j}{m}\right)$$

The general restrictions of classical demand theory are satisfied as the demand equations were derived from a specific utility function.

Rotterdam demand model

The Rotterdam Demand Model was developed by Barten (1969) and Theil (1965) and is based not on a particular utility function but, more generally, on a first-order approximation to the demand functions. The change in x_i can be expressed in terms of income and price changes by a total differentiation of the demand equations (2.2a):

$$\text{(2.24)} \qquad dx_i = (\partial x_i / \partial m)dm + \sum_j (\partial x_i / \partial p_j)dp_j$$

Multiplying both sides of this expression by p_i/m and expressing it in logarithmic form recognizing that dx=xdlnx:

$$\text{(2.25)} \qquad w_i d\ln x_i = p_i(\partial x_i / \partial m)d\ln m + \sum_j (p_i p_j / m)(\partial x_i / \partial p_j)d\ln p_j$$

where w_i is the expenditure share spent on good i, x_i is the quantity of good i, m represents income, and p_i and p_j are prices of the i^{th} and j^{th} goods.

The first term in the right hand side of (2.25) is the income term, which may be written as:

$$\text{(2.26)} \qquad (p_i / m)(\partial x_i / \partial m)dm = \mu_i d\ln m$$

where $\mu_i = p_i(\partial x_i/\partial m) = \partial x_i\, p_i/\partial m$ is the marginal share of the i^{th} commodity. This is the additional amount spent on commodity i when income increases by one unit.

The absolute price version of the Rotterdam model can this way be obtained:

$$w_i d\ln x_i = \mu_i d\ln m + \sum_j \pi_{ij} d\ln p_j \tag{2.27}$$

where π_{ij}'s are called the *Slutsky coefficients* of the Rotterdam model and measure the total substitution effect of a change in the j^{th} price on the demand for the i^{th} commodity or, equivalently, the effect of such a change when real income remains constant.

In the relative price version of the Rotterdam model, the specific and general substitution effects of the price changes are separated:

$$w_i d\ln x_i = \mu_i (d\ln m - \sum_k w_k d\ln p_k) + \sum_j \upsilon_{ij}[d\ln p_j - \sum_k \mu_k d\ln(p_k)] \tag{2.28}$$

where $w_i = p_i x_i/m$ is the share of expenditure on commodity i in total expenditure, $\mu_i = p_i(\partial x_i/\partial m)$ is the marginal budget share of the i^{th} commodity, $(d\ln m - \sum w_k d\ln p_k)$ is a measure of real income, the difference between change in money income and income effect of price changes, v_{ij} is the coefficient of the j^{th} price and $[d\ln p_j - \sum \mu_k d\ln(p_k)]$ is the deflated price of the j^{th} commodity, the difference between the specific substitution and the general substitution effects.

Comparing the relative price version (2.28) with the absolute price version (2.27), the former is non linear and the latter is linear in its parameters. The absolute price version (2.27) can be mainly used with small models, while the relative price version can be used with larger models. The linearity is a point in favor of the absolute price version because it simplifies the estimation procedure. On the other hand, the relative price version has the big advantage that the number of unknown parameters is reduced.

Translog model

The translogs represent a widely used family of flexible functional forms. The "homothetic translog" (HTL) is the simplest member of the translog function. As its name indicates, the HTL

corresponds to homothetic preferences, and hence the corresponding demand system exhibits expenditure proportionality. A consumer has homothetic preferences if he or she has preferences that can be represented by a homothetic utility function, this is a monotonic transformation of an homogeneous function. The HTL indirect utility function is:

(2.29) $$\phi(p,m) = \ln m - \sum \alpha_k \ln p_k - \frac{1}{2}\sum_j \sum_k \beta_{kj} \ln p_k \ln p_j$$

Among the different properties:

(2.30) $$\beta_{ij} = \beta_{ji} \quad \text{for all i,j} \qquad \sum \beta_{ki} = 0 \ \text{ for all i} \qquad \sum \alpha_k = 1$$

The HTL share equations can be obtained by applying Roy's identity:

(2.31) $$x_i(p,m) = -\frac{\dfrac{\partial \phi(p,m)}{\partial p_i}}{\dfrac{\partial \phi(p,m)}{\partial m}}$$ and are given by:

(2.32) $$w_i(p,m) = \alpha_i + \sum_j \beta_{ij} \ln p_j$$

The logarithmic cost function can be obtained from (2.29):

(2.33) $$\ln m = \ln x + \sum \alpha_k \ln p_k + \frac{1}{2}\sum_j \sum_k \beta_{kj} \ln p_k \ln p_j$$

where x is output and m is total cost. This translog cost function is a popular specification in empirical analyses of cost functions and factor demand systems. Other forms of translog functions include the linear translog (LTL) indirect utility function and the log translog (log TL) indirect utility function.

Almost ideal demand system (AIDS)

The Almost Ideal Demand System, developed by Deaton and Muellbauer (1980), gives an arbitrary first-order approximation to any demand system. It satisfies the axioms of choice exactly and aggregates perfectly over consumers without invoking parallel linear Engel curves. The functional

form is consistent with known household budget data and is simple to estimate. Test of the restrictions of homogeneity and symmetry can be made through linear restrictions on fixed parameters. Many of these properties are possessed by either the Rotterdam model or translog model, but neither of them possesses all simultaneously. In the specification of the AIDS model, Deaton and Muellbauer used a specific class of preferences which by the theorems of Muellbauer (1975, 1976) allows an exact aggregation over consumers. Market demands can be represented as if they were the outcome of decisions by a rational representative consumer. Using the dual formulation of the consumer allocation problem, the expenditure or cost function which relates minimum expenditures c to a given level of utility U at given prices p_{ks} (k=1,...., n) can be defined as:

(2.34) $$\ln c(U,p) = \alpha_0 + \sum_k \alpha_k \ln(p_k) + \frac{1}{2}\sum_k\sum_j \delta_{kj}\ln(p_k)\ln(p_j) + U\beta_0 \prod_k p_k^{\beta_k}$$

where α_i, β_i, and δ_{ij} are parameters to be estimated. The demand functions can be derived directly from the AIDS cost function (2.34). It is a fundamental property of the cost function (Shephard, 1953) that its price derivatives are the quantities demanded: $\partial c(U,p)/\partial p_i = x_i$. Multiplying both sides by $p_i/c(U,p)$:

(2.35) $$\frac{\partial \ln c(U,p)}{\partial \ln p_i} = \frac{p_i x_i}{c(U,p)} = w_i$$

where w_i is the budget share of good i. Applying Shephard's lemma to equation (2.34) yields the Hicksian demand function for commodity i in budget share form:

(2.36) $$w_i = \alpha_i + \sum_{j=1}^{n} \delta_{ij}\ln(p_j) + \beta_i U\beta_0 \prod_k p_k^{\beta_k} \text{ for all i, where}$$

(2.37) $$\delta_{ij} = 1/2(\delta_{ij} + \delta_{ji}) = \delta_{ji}$$

is required to satisfy the symmetry condition. Using the duality relation m= c(p,U), the indirect utility function, U(p,m), corresponding to equation (2.34) can be expressed as:

$$(2.38) \quad U = \ln m - \left[\alpha_0 + \sum_{j=1}^{n} \alpha_j \ln(p_j) + \frac{1}{2} \sum_{j=1}^{n} \sum_{k=1}^{n} \delta_{jk} \ln(p_j) \ln(p_k) \right] / \beta_0 \prod p_j^{\beta_j}$$

Substituting (2.38) into equation (2.36) yields the Marshallian demand function for commodity i in share form:

$$(2.39) \qquad w_i = \alpha_i + \sum_{j=1}^{n} \delta_{ij} \ln(p_j) + \beta_i \ln(m / P)$$

The budget share of the i^{th} commodity was already defined as being w_i , p_j is the price of commodity j, m is total expenditure on all commodities in the system, n is the number of commodities included in the system and P is a price index defined by:

$$(2.40) \qquad \ln(P) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln(p_k) + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \delta_{kj} \ln(p_k) \ln(p_j)$$

The AIDS model possesses most of the properties of conventional demand analysis such as adding-up (2.41), homogeneity (2.42) and symmetry (2.43).

$$(2.41) \qquad \sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \delta_{ij} = 0 \qquad \sum_{i=1}^{n} \beta_i = 0$$

$$(2.42) \qquad \sum_{j} \delta_{ij} = 0$$

$$(2.43) \qquad \delta_{ij} = \delta_{ji}$$

Estimation can be done by substituting (2.40) into (2.39) to give:

$$(2.44) \qquad \begin{aligned} w_i &= (\alpha_i - \beta_i \alpha_0) + \sum_{j=1}^{n} \delta_{ij} \ln(p_j) + \beta_i \Big[\ln m - \sum_{k=1}^{n} \alpha_k \ln(p_k) \\ &- \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \delta_{kj} \ln(p_k) \ln(p_j) \Big] \end{aligned}$$

and estimating this system of equations which is nonlinear in parameters. An easier way to estimate (2.39) is to approximate the index P using the Stone's (1954) index $\ln P^* = \Sigma w_k \ln p_k$. If P is proportional to P^* ($P \approx \phi P^*$) then (2.39) can be estimated as the following demand system linear in parameters:

(2.45) $$w_i = (\alpha_i - \beta_i \ln\phi) + \sum_{j=1}^{n} \delta_{ij} \ln(p_j) + \beta_i \ln(m / P^*)$$

The α_i parameters are identified only up to a scalar multiple of β_i. Being $\alpha_i^* = \alpha_i - \beta_i \ln \phi$, it is easily seen that $\Sigma\alpha_i^* = 1$ is still required for adding up, since $\Sigma\, \beta_i = 0$.

It is important to mention that on (2.45), the parameter estimates of δ_{ij} are variant under different price units. Let for example $p_j = \theta_j\, p_j^*$ for some constant $\theta_j > 0$. With these scaled prices, (2.45) becomes:

(2.46) $$w_i = \alpha_i' + \sum_{j=1}^{n} \delta_{ij} \ln(p_j^*) + \beta_i \ln m - \beta_i \sum_{j=1}^{n} w_j \ln(p_j^*), \text{ where}$$

(2.46a) $$\alpha_i' = \alpha_i^* + \sum_{j=1}^{n} \delta_{ij} \ln\phi_j - \beta_i \sum_{j=1}^{n} w_j \ln\phi_j$$

Note that α_i' is a function of w_js, therefore, parameter estimates from (2.46) are different from those estimated from (2.45). As a result the demand parameter estimates obtained from (2.45) vary due to different units used to measure prices.

Looking at (2.39) it can be seen that if P were known , the model would be linear in the parameters α, β, and γ, and the estimation (at least without cross equation restrictions such as symmetry) could be done equation by equation by OLS. The AIDS parameters from (2.39) have no direct economic interpretation until demand elasticities are derived.

After looking at the specification of the different models, a general comparison among them can be performed. The AIDS model preserves the generality of both Rotterdam and translog models. The flexible functional form property of the AIDS cost function implies that the demand functions derived from it are first-order approximations to any set of demand functions derived from utility maximizing behavior. Like in the Rotterdam model, the theoretical restrictions on (2.39) apply directly to the parameters. Both AIDS and Rotterdam model are effectively linear and can be used

to test homogeneity and symmetry with only linear restrictions on constant parameters. The AIDS model is easier to estimate in comparison with the linear expenditure system and the translog model.

Scaling and Translating in Demand Systems

Scaling and translating are two processes commonly used to incorporate the effect of different variables in demand systems. In this study, the impact of demographic, promotion, and health variables on meat demand will be analyzed. The introduction of these variables in demand analysis presents new challenges for both theoretical and applied research. Consider the original demand system represented by (2.2a), this system is assumed to be theoretically plausible being the indirect utility function $\phi(m,p)$, and the direct utility function U(x). This utility function is specified at the household level, and implicitly assumes that households with for example different demographic characteristics have similar preferences. In this case, the influence of demographic characteristics on meat demand can not be evaluated. Scaling and translating are able to replace the original demand system by a related system involving additional parameters that depend on the different variables. The original utility function U(x) is respecified as $U=U(x/\eta)$ where $\eta = (\eta_1, \eta_2, \ldots\ldots, \eta_r)$ are scaling parameters. Recent work of incorporating demographic effects in demand systems includes Parks and Barten (1973), Muellbauer (1977), and Pollak and Wales (1978, 1980).

Demographic scaling

The impact of demographic factors can be incorporated into the direct utility function with a scaling factor (vector of demographic characteristics). The new utility function is $U = f(x_1, \ldots, x_n)/\eta$ where η are the scaling parameters. The original demand system $xi = f_i(p,m)$ is replaced by:

(2.47) $$f_i(p,m) = \eta_i \overline{f_i}(p_1\eta_1, \ldots\ldots, p_n\eta_n, m)$$

The scaling parameters, η's depend on the demographic variables, $\eta_i = T(\eta)$. If the original demand system is theoretically plausible, the modified system will satisfy the first order conditions corresponding to the indirect utility function $\phi(p,m)=\bar{\phi}(p_1\eta_1,.......,p_n\eta_n,m)$ and the direct utility function $U(x)=\bar{U}(x_1/\eta_1,.......,x_n/\eta_n)$. In cases where the scaling functions are the same for all commodities, the scaling parameters η can be interpreted as the adult equivalent index, this is, they reflect the number of "equivalent adults" in the household. On the other hand side if the scaling functions differ from one good to another, then η_i measures the number of equivalent adults on a scale appropriate to commodity i. In either case, both preferences and demand behavior can be seen in terms of quantities and demographically scaled prices.

Demographic translating

Translating represents a procedure to incorporate different variables into demand systems. The original demand system is first replaced by a new system which contains parameters suitable for introducing such variables. The process is completed by specifying the functional form that relates these parameters to the different variables introduced.

The translation procedure facilitates the introduction of parameters that depend on the demographic variables, $d_i = d_i(\mu)$. Pollak and Wales (1992) interpreted demographic translation as necessary or subsistence parameters of demand system to depend on demographic variables. The demand system can be respecified as:

(2.48) $$f_i(p,m) = d_i + \bar{f_i}(p, m - \sum p_k d_k)$$

where d's represent the translating parameters that depend on the demographic variables.

In general if the original system was generated by the indirect utility function $\phi(p,m)$, the modified system satisfies the first order conditions, being generated by:

(2.49) $$\phi(p,m) = \bar{\phi}(p, m - \Sigma p_k d_k)$$

The direct utility function is represented by:

(2.50) $$U(x) = \overline{U}(x_1 - d_1, \ldots\ldots, x_n - d_n)$$

When translating is used to introduce demographic characteristics in demand systems, there is a close relation between the effects of changes in demographic variables and the effects of changes in total expenditure. Changes in the demographic variables affect all d's simultaneously, so, for instance is not possible to conclude that $p_i\, x_i$ increases from an increase in household size which increases d_i. Changes in d's are responsible for allocating the total expenditure among the n goods in such a way that total expenditure remains unchanged.

Modified Prais-Houthakker

Prais and Houthakker (1955) proposed a technique for incorporating demographic variables into demand equations using a single income scale and a specific scale for each good.

In this procedure, the original demand system is replaced by:

(2.51) $$f_i(p,m) = s_i \overline{f_i}(p, m / s_0)$$

where s_i is a commodity specific scale and depends on the demographic characteristics, $s_i = \bar{s}(\mu)$.

s_0 is an income scale defined through the budget constraint

(2.52) $$\Sigma\, p_i s_i \overline{f_i}(p, m / s_0) = m$$

The income scale is a function of all prices, income and demographic variables.

According to Prais and Houthakker, given a household budget data the easiest way to introduce a single demographic variable such as family size is to assume that per capita consumption of each good is a function of per capita expenditure. In this case all types of individuals are assumed

to be identical, with no differences in needs and/or requirements. This problem can be overcome by introducing an equivalent scale that converts the household's demographic profile, η, making this way consumption per equivalent adult a function of expenditure per equivalent adult.

Studies on Meat Demand

Several studies have examined consumers' preferences and attitudes toward meat products (Branson, Cross, Savell, Smith, and Edwards, 1986; Skaggs, Menkhaus, Torok, and Field, 1987; Menkhaus, Whipple, Torok, and Field, 1988). Other studies have examined sources of structural changes in U.S. meat consumption (Nyankori and Miller, 1982; Braschler, 1983; Chavas, 1983; Moschini and Meilke, 1984). Effects of demographic profiles on meat consumption have been examined by (Buse and Salathe, 1978; Cox, 1989; Blaylock and Smallwood, 1986; Nayga and Capps, 1992). Most of these studies focused on aggregated commodities. According to Nayga (1995) aggregation is responsible for a considerable loss of information about consumption patterns. Eales and Unnevehr (1988); Pudney (1981) and Nayga and Capps (1994) have suggested that an analysis of a disaggregated products model is necessary to fully understand meat consumption patterns where consumers choose among meat products rather than among meat aggregates. (Orcutt, Watts, and Edwards, 1968) showed that aggregation carried all the way to the national level can be responsible for loss in effective estimation and testing.

There are also studies dealing with the impact of health, nutrition and quality issues on meat demand (Flake and Patterson, 1999; Capps and Schmitz, 1991; Moon and Ward, 1999) and with the effects of advertizing and promotions on meat demand (Verbeke et al., 2000). Kinnucan and Nayga (1997) were interested on the evaluation of the combined effect of health information and generic advertising on U.S. meat demand.

The presence or absence of structural change in meat demand has been an area of interest for the agricultural economists over the last decade and is critical to marketing decision making. Structural change refers to changes in preferences not related to changes in product prices or income. Although consumers preferences for meat have changed in that more white meat such as chicken and less red meat such as beef is being consumed, there is little consensus as to what has caused these changes. Opinions and empirical results in terms of the structural change influences diverge. According to studies by Moschini and Meilke (1984), Dahlgran (1987), Chalfant and Alston(1988), and Eales and Unnevehr (1993) there has been little or no structural change, implying preferences have remained stable. Major technological advances in the chicken industry, largely flowing from the development of intensive production systems, have meant that the real price of chicken has fallen. In comparison, technological advances in the red meat industry have not been as great, causing chicken to become relatively less expensive. Changes in consumption are explained by changes in prices and expenditures. On the other hand, Nyankori and Miller (1982), Braschler (1983), Chavas (1983), Thurman (1987), Eales and Unnevehr (1988), Moschini and Meike (1989) present evidence of structural change. The reason for consumers' preferences to have changed is the increase in dietary consciousness with white meats being perceived to be healthier than red meats. Also changing lifestyles are causing consumers to demand more convenience foods and poultry is seen to have more value added potential.

Chalfant and Alston (1988) studied the impact of changes in tastes on market demands and concluded that tastes in consumption can only be explained by prices and expenditures and preferences for meat have not undergone structural change. Models that indicate structural change do so because of the functional form chosen.

Gao, Wailes, and Cramer (1997) analyzed taste change both cross-sectionally and intertemporally in an effort to separate the effects of demographic changes from other factors. Using

the AIDS model specification, they concluded that changes in demographic composition of population and other socioeconomic variables have significant impacts on consumer preferences and demand for meat. In particular, results showed that from 1977 to 1987 structural taste changes unexplained by changes in demographic composition decreased 8%. Gao and Spreen (1994) also indicated that population and other socioeconomic variables have significant impacts on consumer demand for meats. Consumer concerns for health and convenience can also cause meat demand to shift.

According to (Goodwin and Koudele, 1990) consumer attitudes towards reduction in red meat consumption can be explained by demographic factors such as household income, size, ethnic origins and consumer age.

Nyankori and Miller (1982) tested hypothesis concerning structural changes in the demand for chicken, beef, pork and turkey. They concluded that structural change occurred in the demand for chicken and beef, but not in the demand for pork and turkey.

Eales and Unnevehr (1988) used disaggregated and aggregated data to test for structural change. In their paper they addressed issues of consumers allocating expenditures among meats by animal origin or by product type and does disaggregation of meat into products in a meat demand model give insight into the causes of structural change? They estimated two meat demand systems with the almost ideal demand systems (AIDS). The first system included aggregate chicken, beef, and pork. The second system disaggregated chicken into whole birds and parts/processed products, and beef into hamburger and table cuts. They rejected the hypothesis that consumers allocate expenditures first to animal product aggregates such as beef or chicken and then among products within an aggregate. Instead, consumers do allocate expenditures across all meat products at once or between high and low quality products from different animals. The use of aggregate chicken and beef could be responsible for bias in the estimation of demand parameters and hence tests for structural change.

Tests for structural change at the disaggregate level results were different. Two types of significant shifts in meat demand were growth in the demand for chicken parts/processed from 1965 to 1985 and a decline in demand for beef table cuts after 1974. Also, demand for whole birds declined and demand for hamburger increased. Faced with these results, they rejected the hypothesis (Chavas, 1983) that health concerns have been the driving force behind the shift from beef to chicken. If his hypothesis were true, a growth in whole birds and a decline in hamburger would have been seen. Finally, they inferred that increased demand for convenience could be a possible explanation for the growth in chicken parts because the value of time for the principal meal of the day has increased during the last twenty five years. Also, their findings suggest that the chicken industry responded to these changing preferences through new products development. They suggest that to gain a full understanding of meat demand, disaggregated products models must be used.

Eales and Unnevehr (1993) studied simultaneity and structural change in U.S. meat demand. Given that red meats are perishable and a long production lag exist, quantity supplied is likely to be predetermined and quantity dependent demand models may be inappropriate. In this paper they raised the questions: if when estimating a system of U.S. meat demands can quantities or prices be taken as predetermined or are both endogenous? Are findings of structural change in demand, such as shift in beef demand in the mid 70s, explained by supply side variables? In order to get an answer to these questions they tested the endogeneity of prices and quantities in a meat demand system using the AIDS model and an inverse of the Almost Ideal Demand System (IAIDS). The IAIDS has all the desirable theoretical properties of the AIDS except aggregation from the micro to the market level. They concluded that prices and quantities are both endogenous in the meat demand system as a whole; however tests of individual variables indicate that beef quantity could be predetermined. The typical demand model in which prices are assumed predetermined is misspecified, what can influence parameter estimates, including findings of structural change in demand. They also concluded that

findings of structural change in demand, such as shift in beef demand in the mid 70s can be explained by supply side variables.

Nayga and Capps (1994) were interested in better understanding how consumers make decisions concerning purchase patterns of meat expenditures. Do consumers select among various cuts or qualities of a particular type of meat and/or among meat types of like quality? Using the absolute price version of the Rotterdam Model, they concluded that in analyzing the demand for meat products, one may not focus only on the demand for beef products, or on the demand for pork products, or on the demand for poultry products. And also not only on the demand for either high quality or low quality meats. One must consider the demand for all types of meat products simultaneously.

Moschini and Meilke (1989) tested the hypothesis of structural change in U.S. meat demand in a four meat almost ideal demand system. The objective of this paper was to provide further evidence of the existence and nature of structural change in meat demand. They used the linear version of the almost ideal demand system (AIDS) derived by Deaton and Muellbauer that is able to provide a first-order approximation to an arbitrary demand system and that satisfies perfect aggregation over consumers. Their results supported the idea that meat consumption patterns of the last two decades cannot be fully explained by the dynamics of prices and income. Structural change is biased against beef, neutral for pork, and in favor of fish and chicken. There is a movement towards an increased importance of white meats, further supporting the idea that dietary concerns are partly responsible for the perceived changes in meat consumption patterns. The implications of this are particularly relevant for the beef industry, calling possibly for a quality adjustment in production and increased efforts in promotion and marketing.

Flake and Patterson (1999) were interested on determining if media information on food safety issues has affected demand for beef and other meats. In this study they used a linear

approximation of the AIDS model in which they combined measures of food safety and health information. They concluded that both safety and health attributes influence beef demand, although results indicated that beef safety information had a relatively modest impact on beef consumption. Capps and Schmitz (1991) did some studies in which they considered health and nutrition factors in demand analyses. They were interested on the identification of the impacts of information pertaining to cholesterol and fat on the demands for beef, poultry and fish. In their analyses they used the Rotterdam Model and concluded that health and nutrition factors should be taken into account in food demand studies. Moon and Ward (1999) were interested on the effects of health concerns and consumer characteristics on U.S. meat consumption. This study specified an empirical meat demand model incorporating health concerns and demographic variables. Results showed linkages between health concerns and meat consumption. Specifically, health concerns varied across five meat categories, including beef, pork, chicken, turkey and fish.

Verbeke et al. (2000) analyzed the potential impact from mass media coverage and demographic consumer characteristics on decision making towards fresh meat.

Kinnucan and Nayga (1997) studies focused on whether the combined effect of generic advertizing and health information have effects on U.S. meat demand. Studies done by (Ward and Lambert, 1993; Capps and Schmitz, 1991; McGuirk, Discoll, Alwang, and Huang, 1995) suggested that generic advertising and health information when separately analyzed influence meat consumption patterns. The Rotterdam model was used because it is consistent with demand theory (Barten, 1964 and Theil, 1965), flexible as another local approximation form (Mountain, 1988), lends itself to advertising applications (Brown and Lee, 1993) and it is more consistent with U.S. meat demand behavior than the linear approximation of the Almost Ideal Demand System (Alston and Chalfant, 1993). Results suggested that health information has a pronounced effect on meat consumption, while the effects of generic advertizing are modest.

Overall, linear expenditure allocation models such as AIDS, Rotterdam, translog have been used throughout the last years in an enormous number of studies dealing not only with meat demand, but with food demand in general. For instance, the AIDS model was used on studies done by Glaser and Thompson (1998) on the analyze of the demand for organic and conventional frozen vegetables, Capps, Tedford, and Havlicek (1985) on the study of household demand for convenience and nonconvenience foods, Tambi (1988) on testing for habit formation in food commodity consumption patterns in Cameroon and by Blanciforti and Green (1983).

Drawing on the papers presented in this chapter, demand will be specified and estimated in the following chapters. In particular, Chapter 4 will set forth the model specification, while Chapter 5 will include the parameter estimates and their discussion. Chapter 3 will be dealing with data and consumer statistics.

CHAPTER 3
DATA AND CONSUMER STATISTICS

The data used in this analysis are based on household panel reports collected by the National Panel Diary Group company (NPD, 1998). NPD is an independent company specialized in sampling and collection of panel data on consumer attitudes, demographics and consumption practices, and they spend considerable effort in making sure the panels are demographically representative of U.S. households. NPD sends every month a questionnaire to the households and the company maintains the household panel where participating households keep eating diaries, documenting their purchasing habits for a designated time. An individual head of the household that can be either male or female reports his eating occasions within the home, recording the types of meat products consumed. Specifically, households report the quantity and expenditure of each meat product consumed along with the detailed cuts within each meat type purchased in a two-week time period. Each household is identified by a family code. When households are no longer representative of U.S. population they are excluded from the panel. The two week reporting time period is designated as wave that is a numerical code corresponding to a month and year. Households may not consistently report each time period.

Knowing the number of members in a household, it is possible to determine the quantity purchased per household member. Prices can be determined from the expenditures and quantities of each meat type purchased. Data on most demographics are readily available for the monthly database extending from the last quarter of 1992 through the first quarter of 1998. The full data set includes information on household demographics and the quantities and expenditures of the different

households on beef, fish, poultry and pork for a total of 570,229 observations. Specific cuts or categories of the meats are also recorded. Information on households concerns for health issues, such as fat and cholesterol, is also available from NPD. In addition, quarterly data on beef advertizing and promotion expenditures for the same periods are available.

Description and Definition of Variables

The original data was coded by household, period, and product with each entry representing one observation for a total of 570,229. In order to complete later demand models it is essential that the data be arranged by household and time period with each household entry showing the purchases of each type of meat. Hence, the original data set was reorganized with the rows representing household codes and time periods and the columns including all purchasing decisions along with demographics and related information. In this way, one can easily show the share of expenditures spent on the different products by each household, including zero expenditures.

From the original data with 570,229 observations the new data set included 68,844 observations. Missing values for waves and family codes were removed from the data base. A variety of demographic characteristics, quantities and expenditures on different types of meat purchased are included in the data set for beef, fish, poultry and pork with each meat type having unique columns and codes as shown in Table 3.1. For instance the code 557 represents beef, the code 558 fish, 559 poultry and 560 pork, being all of them carried in the quantity and expenditure definitions. Each household may not report the same number of times over the full period from 1992 through 1998. The minimum number of times a household reports is one and the maximum is 68 times. When the household just reports one time (one wave), it is possible that a purchase of one or

Table 3.1: Description of selected variables from the NPD household meat consumption data.

DEMOGRAPHICS	QUANTITIES
DINC = household income (1= under \$25,000, 2=\$25,000 to \$49,999, 3=\$50,000 to \$74,999, 4=over \$75,000)	Q557TOT = pounds of beef purchased per household in a wave
DHSZ = household size (1=1 member, 2=2 members, 3=3 members, 4=4 or more members)	Q558TOT = pounds of fish purchased per household in a wave
DAGF = age of female head (1=29 and under, 2=30 to 49, 3=over 50)	Q559TOT = pounds of poultry purchased per household in a wave
DCHD = presence of children under 18 years (1=yes, 2=no)	Q560TOT = pounds of pork purchased per household in a wave
DEMF = employment of female head (1=unemployed, 2=0 to 30 hours a week, 3=over 30 hours a week)	Q55701 = pounds of beef (roast) purchased per household in a wave
DEDF = education of female head (1=high school, 2=college, 3=post college graduate)	Q55702 = pounds of beef (steak) purchased per household in a wave
DSTA = census region (1=east, 2= central, 3=south, 4=west)	Q55703 = pounds of beef (other types of beef)) purchased per household in a wave
DMSA = market size (1=0 to 49,999, 2=50,000 to 249,999, 3=over 250,000)	Q55704 = pounds of beef (ground beef) purchased per household in a wave
	Q55901 = pounds of poultry (chicken) purchased per household in a wave
	Q55902 = pounds of poultry (turkey) purchased per household in a wave
	Q55903 = pounds of poultry (other types of poultry) purchased per household in a wave

more meat types was not made. However, this does not mean that the household is not a consumer of that particular meat type. During a two week time period, a household may not purchase and consume a certain meat type, such as fish. However if during two or more reporting times a

Table 3.1: Continued.

EXPENDITURES	OTHER VARIABLES
E557TOT = expenditures on beef purchased per household in a wave	PRCHL = percent of households reporting completely or moderately agree with cholesterol concern
E558TOT = expenditures on fish purchased per household in a wave	PRFAT = percent of households reporting completely or moderately agree with fat concern
E559TOT = expenditures on poultry purchased per household in a wave	PRO = quarterly expenditures on beef promotions
E560TOT = expenditures on pork purchased per household in a wave	ADVR = quarterly advertising expenditures on beef
E55701 = expenditures on roast purchased per household in a wave	LNA#PK = quarterly advertising expenditures on pork
E55702 = expenditures on steak purchased per household in a wave	LNA#PL = quarterly advertising expenditures on chicken
E55703 = expenditures on other beef purchased per household in a wave	LNA#TK = quarterly advertising expenditures on turkey
E55704 = expenditures on ground beef purchased per household in a wave	
E55901 = expenditures on chicken purchased per household in a wave	
E55902 = expenditures on turkey purchased per household in a wave	
E55903 = expenditures on other types of poultry purchased per household in a wave	

household does not purchase any fish, this might indicate that the household does not consume fish. The number of reporting times will be important as an indication if a household is a consumer of the different meat types and cuts. Table 3.1 provides a description of the different variables and how

each one is coded. The household and time series suggest the potential for using data pooling techniques by pooling cross-sections and time series.

Demographics are measured with income levels, household sizes, ages of females, presence of children in the household, female employment status, female education levels, geographic regions (by state) and market sizes. Both the quantity and expenditures are reported for beef, fish, poultry and pork and then into some subcategories depending on the meat type. Beef purchases are in four subcategories: roasts, steaks, ground beef, and other beef products. Poultry purchases are divided into three subcategories: chicken, turkey and other poultry products. Fish and pork are not subdivided.

NPD maintains a separate panel where consumers are asked to indicate their concerns about health issues. Households respond to the statement that "a person should be concerned about cholesterol and fat" by using a five point scale of degree of concern. A health index was created from these data and incorporated into the meat eatings database. Finally, promotion expenditures on several of the meat types were included in the data set.

In the full data set, there is information of the percentage of households reporting that completely or moderately agree with cholesterol concern. NPD households were asked to rank their concerns about cholesterol and fat on a five point Likerd scale with five different categories: completely concern, moderately concern, indifferent, mostly not concern and strongly not concerned. This scale is applied to questions such as "a person should be concerned about cholesterol and fat." Based on the households' responses, a health concern index was created and will be used in the demand models.

National media advertising represents about 80 percent of the effort spent to increase household expenditures on beef. The other 20 percent of the effort is taken by consumer and industry information, including recipes, brochures, printed material and pamphlets. LNA (Leading National Advertiser) data are also used to measure media advertising on pork and poultry.

Descriptive Statistics of Panel Variables

Frequency of Distribution of Reporting

The NPD data set includes 7520 different households and the frequency of reporting can vary across the households. Table 3.2 presents the frequency of the households reporting across the time of the survey spanning the last quarter of 1992 through the first quarter of 1998. From the 7520 different households, 25.76 percent (1936) reported just one time. In comparison, 2.30 percent of the households reported 10 times and less than one percent of the households reported 17 times. The frequency of households reporting will be important for the model development in Chapter 4. As seen in Table 3.2, households can report from one to 68 times. In the case of the household just reporting one time, the purchase of a certain meat type could be zero during the two week time period. However, this does not mean that the household does not consume that meat type. Rather a particular household may simply not purchase a certain meat type during that two week time period. Households reporting no purchase of a certain meat type over several waves may indicate that they do not consume that meat type. This concept is important since one must determine if the household is or is not a consumer of, say, beef. The household could be a beef consumer but choose not to purchase during a particular reporting period or may simply not consume beef. From the 7520 different households considered in this study, 12 (.16 percent) did not purchase any type of meat during the time of the survey. This result is in agreement with reports from the Vegetarian Resource Group stating that less than one percent of the U.S. population are vegetarian. Since households do not report consistently over the period of the survey, standard econometric pooling procedures are not

Table 3.2: Distribution of the frequency of the households reporting across the data set.

Frequency of reporting	Number of household (percentage)	Frequency of reporting	Number of household (percentage)
1	1936 (25.76%)	35	31 (.412%)
2	965 (12.84%)	36	19 (.253%)
3	643 (8.55%)	37	16 (.213%)
4	494 (6.57%)	38	23 (.306%)
5	393 (5.23%)	39	27 (.359%)
6	320 (4.26%)	40	16 (.213%)
7	297 (3.95%)	41	21 (.279%)
8	216 (2.88%)	42	12 (.160%)
9	203 (2.70%)	43	18 (.239%)
10	173 (2.30%)	44	14 (.186%)
11	133 (1.77%)	45	15 (.200%)
12	129 (1.72%)	46	11 (.146%)
13	95 (1.26%)	47	12 (.160%)
14	92 (1.22%)	48	19 (.253%)
15	78 (1.04%)	49	16 (.213%)
16	78 (1.04%)	50	18 (.239%)
17	74 (.984%)	51	16 (.213%)
18	73 (.971%)	52	13 (.173%)
19	59 (.785%)	53	13 (.173%)
20	56 (.745%)	54	10 (.133%)
21	51 (.678%)	55	15 (.200%)
22	47 (.625%)	56	11 (.146%)
23	40 (.532%)	57	12 (.160%)
24	52 (.692%)	58	11 (.146%)
25	46 (.612%)	59	7 (.0931%)
26	36 (.479%)	60	4 (.0532%)
27	42 (.559%)	61	9 (.120%)
28	43 (.572%)	62	9 (.120%)
29	36 (.479%)	63	9 (.120%)
30	39 (.519%)	64	9 (.120%)
31	26 (.346%)	65	5 (.0665%)
32	27 (.359%)	66	13 (.173%)
33	37 (.492%)	67	6 (.0798%)
34	25 (.333%)	68	3 (.0399%)

appropriate. Furthermore, the large number of households would prohibit the use of standard pooling procedures. These issues will be discussed in Chapter 4.

Demographic Variables

The distribution of the different demographic variables is presented in Table 3.3. Households with incomes lower than $50,000 accounted for 69 percent of the total number of households, while 12 percent of the households had incomes above $75,000. Within the household size measured with the number of family members, more than 50 percent of the households had three or more members. About 55 percent of the adult females in the households reporting their age were between 30 and 50 years old and 20 percent were under 30 years old. Within the 7520 households, there was no information from 681 households regarding the demographics age of female. The distribution of the presence of children under and over 18 years old at home was equal among the 7520 households. Regarding female employment level and education of female, there were no statistics from 681 households. About 46 percent of the respondents worked full time defined as over 30 hours a week. In terms of education level, 49 percent of the female heads had a college education and 43 percent only completed high school. Approximately eight percent had post college education. Regionally, 36 percent of the panel lived in the southern region of the United States defined to include South Atlantic, East and West South Central states. About 24 percent lived in the East and West North Central states, 19 percent in the Eastern part of the United States including New England and the Middle Atlantic states, and 21 percent lived in the Western region or Mountain and Pacific states. More than 65 percent of the households lived in cities with population of 250,000 or more. About 9 percent lived in mid-sized cities of 50,000 to 250,000 people and 21 percent lived in rural areas with under 50,000 population.

In order to analyze the correlation among the different demographic variables Table 3.4 was constructed. From this table it can be seen that the coefficient of correlation between the variable

Table 3.3: Variable definitions for NPD household meat consumption data.

Type of variable	Variable	Range	Number of household (percentage)
Demographics: income (dollars)	INC_1	0 to $24,999	2500 (33.25%)
	INC_2	$25,000 to $49,999	2713 (36.08%)
	INC_3	$50,000 to $74,999	1376 (18.30%)
	INC_4	over $75,000	931 (12.38%)
Demographics: household size(number of people)	HSZ_1	1	1072 (14.26%)
	HSZ_2	2	2210 (29.39%)
	HSZ_3	3	1482 (19.71%)
	HSZ_4	4 plus	2756 (36.65%)
Demographics: age of female (years)	AGF_1	29 and under	1318 (19.27%)
	AGF_2	30 to 49	3788 (55.39%)
	AGF_3	over 50	1733 (25.34%)
Demographics: age and presence of children (years)	CHD_1	presence of children under 18	3740 (49.73%)
	CHD_2	no children under 18	3780 (50.27%)
Demographics: female employment level (hours)	EMF_1	unemployed	2771 (40.52%)
	EMF_2	0 to 30	908 (13.28%)
	EMF_3	over 30	3160 (46.21%)
Demographics: female education level	EDF_1	high school	2924 (42.75%)
	EDF_2	college	3359 (49.12%)
	EDF_3	post college graduate	556 (8.13%)
Demographics: census region	STA_1	east	1459 (19.40%)
	STA_2	central	1780 (23.67%)
	STA_3	south	2711 (36.05%)
	STA_4	west	1570 (20.88%)
Demographics: market size(number of people)	MSA_1	0 to 49,999	1650 (21.94%)
	MSA_2	50,000 to 249,999	698 (9.28%)
	MSA_3	over 250,000	5172 (68.78%)
Seasonality (quarters)	QTR_1	January-March	1927 (25.62%)
	QTR_2	April-June	1959 (26.05%)
	QTR_3	July-September	1606 (21.36%)
	QTR_4	October-December	2028 (26.97%)

presence of children in the household and household size is quite high, 0.76. In the same table, the variable presence of children in the household shows a high correlation with the variable age of female. For these reasons, the presence of children in the household should not be included in the model specification (later in Chapter 4). It is essential, however, that the model accounts for the total number of members in the household, including the number of children. Since the number of children is nested within the total household size and this variable can easily differ across age groups, the inclusion of household size was considered the appropriate demographic measure of consuming units within the household.

Table 3.4: Correlation among the different demographic variables present in the NPD data set.

	DINC	DHSZ	DAGF	DCHD	DEMF	DEDF	DSTA	DMSA
DINC	1.00	0.21	-0.09	0.07	0.24	0.37	-0.01	0.23
DHSZ	0.21	1.00	-0.43	0.76	0.02	0.04	-0.01	0.03
DAGF	-0.09	-0.43	1.00	-0.55	-0.23	-0.12	-0.01	-0.02
DCHD	0.07	0.76	-0.55	1.00	0.05	0.06	0.01	0.01
DEMF	0.24	0.02	-0.23	0.05	1.00	0.18	-0.04	0.02
DEDF	0.37	0.04	-0.12	0.06	0.18	1.00	0.07	0.13
DSTA	-0.01	-0.01	-0.01	0.01	-0.04	0.07	1.00	-0.03
DMSA	0.23	0.03	-0.02	0.01	0.02	0.13	-0.03	1.00

Quantity and Expenditure Variables

In order to provide the reader with some insight into the data set used in this research, Tables 3.5, 3.6 and 3.7 were constructed. These tables show some data statistics for the different types of meat, including the different beef and poultry cuts. Comparing the different expenditure shares, beef

accounts for the largest amount with 41.41 percent of the total meat household expenditures, while fish shows the smallest share with 12.38 percent (Table 3.5). Looking at the shares by expenditure in a quarter basis, there is clearly an increase on household expenditures in poultry and pork during the last quarter of a year, corresponding to the Thanksgiving and Christmas time periods. During this same time period, there is a decrease on the household expenditures on beef. From the 7520 different households present in the data set and within a two week time period, 8.32 percent did not purchase any beef, 41.85 percent did not purchase any fish, 9.35 percent poultry and 21.57 percent any pork. The degree of difference that the different meat products make can be shown with the coefficients of variation of each series (e.g., $CV=\sigma/\mu$). Relative variations on fish expenditures were about 3 times higher in comparison with household poultry expenditures. In average households purchased 11.49

Table 3.5: Some statistics of the household data set for the four different meat products.

		Beef	Fish	Poultry	Pork
Share by Quantity		36.77%	6.11%	37.09%	20.03%
Share by Expenditure		41.41%	12.38%	24.97%	21.24%
Share by Expenditure in Quarter Basis	Quarter 1	41.16%	13.66%	24.68%	20.57%
	Quarter 2	42.59%	12.55%	23.59%	21.07%
	Quarter 3	43.53%	12.08%	24.50%	19.79%
	Quarter 4	38.81%	11.18%	26.85%	23.13%
Percent of households buying		91.68%	58.15%	90.65%	78.43%
Coefficient of variation across sample		1.69	3.66	1.30	1.68
Average purchase size (pounds)		10.40	4.42	11.49	7.54
Average expenditure (dollars)		20.47	15.64	13.51	13.97

pounds of poultry during the time of the survey. The highest household expenditures were in beef, with an average value of $20.47.

Table 3.6 presents some statistics for the four beef products. From the total quantity (pounds) of beef purchased by the households, 45.69 percent was of ground beef, 23.25 percent of steaks, with roasts and other beef products accounting for the lower values. In terms of dollar expenditures, ground beef and steaks accounted for the higher values, with 36.11 and 32.93 percent respectively.

Table 3.6: Some statistics of the household data set for the four different beef products.

	Roasts	Steaks	Other beef	Ground beef
Share by Quantity	16.21%	23.25%	14.85%	45.69%
Share by Expenditure	15.80%	32.93%	15.16%	36.11%
Percent of households buying	52.91%	65.57%	50.76%	83.01%
Coefficient of variation across sample	2.36	2.42	8.01	1.69
Average purchase size (pounds)	4.95	4.66	5.75	6.61
Average expenditure (dollars)	9.49	13.00	11.55	10.28

Within the beef group, from the 7520 households that participated in the survey, more than 80 percent purchased some ground beef within a two week time period. The percentage of households buying roasts and other beef products was around 50 percent, while 65 percent purchased some steaks. The highest variation among household expenditures was presented by other beef products, with a coefficient of variation of 8.01. Ground beef was the beef product with the highest household average purchase size (6.61 pounds). Steaks accounted for the highest average household expenditures, immediately followed by other beef products and ground beef.

The same data statistics are presented for the four poultry products in Table 3.7. Chicken and turkey accounted for more than 95 percent in both quantity and expenditure shares. During the time of the survey that run from the last quarter of 1992 until the first quarter of 1998, 87 percent of the households purchased some chicken, 55 percent some turkey, and 10 percent other types of poultry products. Expenditures on other types of poultry products presented the highest variation with a coefficient of variation of 15.26. Turkey was the poultry product with the highest value in terms of average household purchases, while chicken presented the highest value in terms of average household expenditures.

Table 3.7: Some statistics of the household data set for the four different poultry products.

	Chicken	Turkey	Other Poultry
Share by Quantity	72.56%	26.40%	1.03%
Share by Expenditure	77.22%	21.55%	1.23%
Percent of households buying	87.15%	55.00%	10.03%
Coefficient of variation across sample	1.47	2.61	15.26
Average purchase size (pounds)	9.22	9.39	4.60
Average expenditure (dollars)	11.54	9.01	6.32

Descriptive Statistics for Household Expenditures Shares

Households can spend anywhere from zero to 100 percent of their meat expenditures on beef or other meats. As shown in the previous table the share is generally around 41 percent for beef based

on the full NPD data set. A data issue of importance to later econometric analysis is whether or not the distribution of expenditures across the types of meat is someway tied to the reporting frequency of the households. Later modeling is intended to show how demographics and other variables influence the meat shares using various expenditure allocation models where the share of expenditures to each meat type is predicted. If the variation in expenditures on beef changes with the reporting frequently, clearly the economic models are not going to be as useful since some of the variation is related to the sampling instead of differences across the households. Hence, before using these data for econometric modeling it is necessary to have a clear view of how sampling influences the expenditure distributions on each type of meat. One particular concern is with the sampling issues when a household reports only one time versus reporting over two or more waves. Is there a difference when the frequency of reporting increases (or decreases)?

In order to try to identify the households that consume a certain type of meat, household expenditures were determined for different reporting times. This is particular important for identifying households that consume beef, ground beef and chicken. These three meat products are the ones having the highest values in terms of household expenditure shares.

During a two wave period (1 month), there is enough time for a household to buy a particular type of meat. The relation between the number of times a household reports and the expenditures shares on different types of meat will be particular important for the model development in Chapter 4. Households reporting just one time may not be representative of the purchase of the different types of meat.

Table 3.8 shows the distribution of household expenditures on beef across different household reporting frequencies. The rows in this table show the share of expenditures on beef with the shares expressed in groups ranging from zero to 100 percent in increments of 10 percent. Each

Table 3.8: Descriptive statistics for household expenditures shares on beef for households reporting different number of times.

	Number of times households report (percentage)						
Beef Share Expenditures	1 (25.76%)	2 (12.84%)	3 (8.55%)	5 (5.23%)	10 (2.30%)	15 (1.04%)	at least 2 (74.26%)
	Number of households (percentage)						
0[1]	397 (20.64)	104 (10.78)	35 (5.44)	12 (3.05)	3 (1.73)	1 (1.28)	216 (3.87)
0-10%	80 (4.160)	55 (5.70)	33 (5.13)	24 (6.11)	6 (3.47)	4 (5.13)	272 (4.87)
10%-20%	144 (7.488)	94 (9.74)	63 (9.80)	30 (7.63)	16 (9.25)	7 (8.97)	506 (9.06)
20%-30%	181 (9.412)	127 (13.16)	100 (15.55)	59 (15.01)	24 (13.87)	11 (14.10)	806 (14.43)
30%-40%	216 (11.23)	132 (13.68)	91 (14.15)	73 (18.58)	34 (19.65)	23 (29.49)	1038 (18.59)
40%-50%	220 (11.44)	134 (13.89)	104 (16.17)	72 (18.32)	48 (27.74)	9 (11.54)	1032 (18.48)
50%-60%	165 (8.58)	101 (10.47)	93 (14.46)	70 (17.81)	17 (9.83)	15 (19.23)	783 (14.02)
60%-70%	146 (7.59)	77 (7.98)	54 (8.40)	20 (5.09)	13 (7.51)	5 (6.41)	448 (8.02)
70%-80%	92 (4.78)	53 (5.49)	37 (5.75)	17 (4.33)	6 (3.47)	1 (1.28)	251 (4.49)
80%-90%	75 (3.90)	42 (4.35)	21 (3.27)	12 (3.05)	6 (3.47)	1 (1.28)	141 (2.53)
90%-100%	22 (1.14)	14 (1.45)	5 (.78)	2 (.51)		1 (1.28)	41 (.73)
100%	185 (9.62)	32 (3.32)	7 (1.09)	2 (.51)			50 (.90)

[1] 0=no beef purchased

column then accounts for those households that report one time, two times, etc. Households that reported one time, two times, three, five, ten and fifteen times during the time of the survey (October 1992 through June 1998) are considered in this analysis. Considering the households that reported just one time (25.76% of the 7520 different households), about 20 percent of the households did not purchase beef and 9.62 percent just purchased beef. About 11.44 percent of the households that reported one time, accounted for between 40 and 50 percent of share expenditures on beef. As the number of reporting times increases, from one time to fifteen times, there is a decrease on the share frequency household expenditures in the cases where no meat is purchased and share expenditure is greater than 60 percent. The most pronounced effect can be seen when the number of reporting times increases from one to two. There is a difference of 9.86 percentage points between the number of households not purchasing any beef in a two week time period and within a month time period. The far right column in Table 3.8 shows the household share expenditures on beef for the case of the households reporting at least two times. In Figure 3.1 the distribution of household expenditures shares on different types of meat is presented along the different number of times households report for the case of zero share of total expenditure (no meat or beef purchased). As the number of times households report goes up, there is a decrease in the share frequency household expenditures for all types of meat. When the household reports fifteen times, expenditures on meat become relatively constant. This gives an idea of the households that are consumers of the different types of meat. If a household reports during two times the purchase of for example beef, she is supposed to be a beef consumer. This will be particularly important to Chapter 4, where the models are developed and specified. Information on the number of times households report and its influence on expenditures shares will be useful for aggregation purposes in Chapter 4. It helps answering questions such as: How many households are going to be considered in the model? Just the ones that reported at least two times or all of them? In the case of the household reporting 15 times, there might be the risk of the

sample being too small. This way it would not be representative of the households included in the survey. The descriptive statistics for household expenditures shares can this way be justified. The

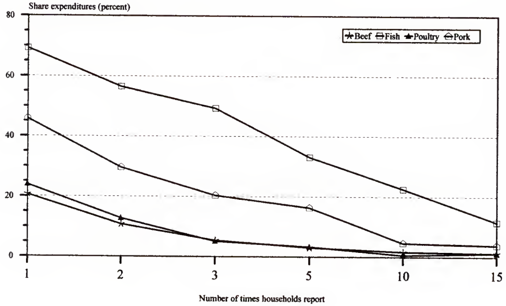

Figure 3.1: Distribution of household expenditures shares on different types of meat along different number of times households report.

distribution of share frequency household expenditures on ground beef and chicken for different household reporting times are presented in Tables 3.9 and 3.10 respectively. Considering the households that reported three times, 10 percent of them did not buy any ground beef, while 11.67 percent just bought ground beef. As it was already seen with the household purchasing beef, the greatest changes occur between the households reporting one time and two times. In this case, there is a decrease of 4.14 percentage points in the number of households not purchasing any ground beef. In the case of households just purchasing chicken there is a decrease in expenditures as the

Table 3.9: Descriptive statistics for household expenditures shares on ground beef for households reporting different number of times.

	Number of times households report (percentage)					
Ground beef Share Exp.	1(25.76%)	2(12.84%)	3(8.55%)	5(5.23%)	10(2.30%)	15(1.04%)
	Number of households (percentage)					
0[1]	306 (20.05)	137 (15.91)	62 (10.19)	23 (6.04)	5 (2.94)	4 (5.19)
0-10%	39 (2.56)	34 (3.95)	29 (4.77)	25 (6.56)	14 (8.24)	3 (3.90)
10%-20%	87 (5.70)	69 (8.01)	48 (7.89)	38 (9.97)	17 (10.00)	6 (7.79)
20%-30%	99 (6.49)	80 (9.29)	60 (9.87)	44 (11.55)	9 (5.29)	18 (23.37)
30%-40%	136 (8.91)	66 (7.67)	73 (12.00)	57 (14.96)	21 (12.35)	10 (12.98)
40%-50%	92 (6.03)	88 (10.22)	72 (11.84)	41 (10.76)	29 (17.05)	8 (10.38)
50%-60%	114 (7.47)	78 (9.06)	51 (8.39)	33 (8.66)	28 (16.47)	7 (9.09)
60%-70%	64 (4.19)	56 (6.50)	53 (8.72)	38 (9.97)	10 (5.88)	10 (12.98)
70%-80%	49 (3.21)	49 (5.69)	41 (6.74)	21 (5.51)	15 (8.82)	5 (6.49)
80%-90%	35 (2.29)	27 (3.14)	37 (6.08)	23 (6.04)	9 (5.29)	4 (5.19)
90%-100%	7 (.46)	9 (1.05)	11 (1.81)	3 (.79)	4 (2.35)	1 (1.30)
100%	498 (32.63)	168 (19.51)	71 (11.67)	35 (9.19)	9 (5.29)	1 (1.30)

[1] 0=no ground beef purchased

Table 3.10: Descriptive statistics for household expenditures shares on chicken for households reporting different number of times.

	Number of times households report (percentage)					
Chicken Share Exp.	1(25.76%)	2(12.84%)	3(8.55%)	5(5.23%)	10(2.30%)	15(1.04%)
	Number of households (percentage)					
0[1]	139 (9.50)	56 (6.65)	21 (3.44)	9 (2.37)	2 (1.16)	1 (1.30)
0-10%	4 (.27)	6 (.71)	7 (1.15)	2 (.53)		
10%-20%	14 (.96)	16 (1.90)	8 (1.31)	3 (.79)	1 (.58)	2 (2.60)
20%-30%	41 (2.80)	18 (2.14)	8 (1.31)	10 (2.63)	4 (2.33)	
30%-40%	38 (2.60)	26 (3.09)	23 (3.77)	12 (3.16)	7 (4.07)	4 (5.19)
40%-50%	45 (3.08)	45 (5.34)	30 (4.92)	19 (5)	7 (4.07)	4 (5.19)
50%-60%	35 (2.39)	43 (5.11)	41 (6.72)	37 (9.74)	12 (6.98)	7 (9.09)
60%-70%	49 (3.35)	37 (4.39)	51 (8.36)	25 (6.58)	12 (6.98)	10 (12.99)
70%-80%	52 (3.55)	59 (7.01)	58 (9.51)	42 (11.05)	29 (16.86)	14 (18.18)
80%-90%	46 (3.14)	48 (5.71)	47 (7.70)	49 (12.89)	29 (16.86)	18 (23.38)
90%-100%	10 (.68)	37 (4.39)	28 (4.59)	31 (8.16)	27 (15.70)	11 (14.28)
100%	990 (67.67)	451 (53.56)	288 (47.21)	141 (37.10)	42 (24.42)	6 (7.79)

[1] 0=no chicken purchased

number of times households report goes up. About 67 percent of the households that just reported one time purchased only chicken, while only about 7 percent of the households that reported 15 times purchased only chicken.

As it was already seen with the four different types of meat, as the number of times households report goes up, there will be a decrease in the share frequency household expenditures for all types of beef and poultry. These shares start being relatively constant when the number of times households report is fifteen. Figures 3.2, 3.3.and 3.4. show the distribution of household share of each type of meat purchased along different time periods: two weeks (wave), month and year respectively. The degree of difference that the reporting frequency makes can be shown with the coefficients of variation of each series (e.g., CV=σ/μ). In Figure 3.2, the relative variations in the fish

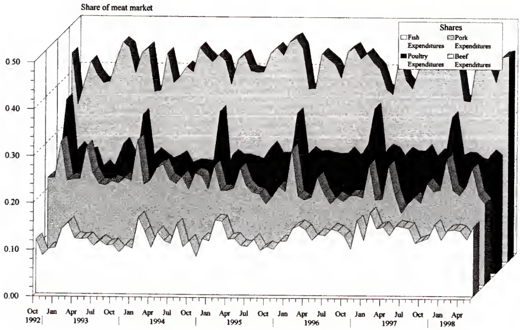

Figure 3.2: Distribution of household share of each type of meat purchased along the time (waves).

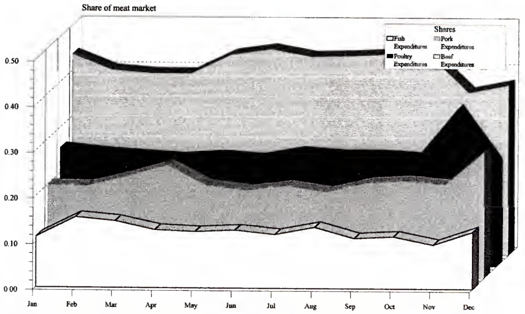

Figure 3.3: Distribution of household share of each type of meat purchased along the time (months).

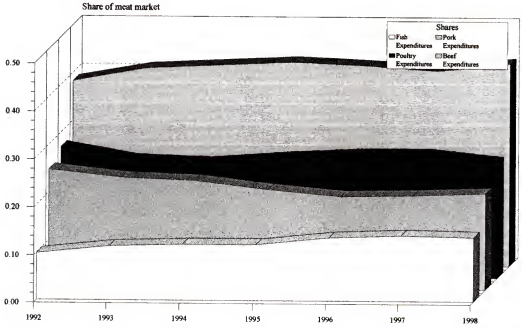

Figure 3.4: Distribution of household share of each type of meat purchased along the time (years).

share frequency of total expenditures are over 2.0 times that for beef expenditure shares. Coefficients of variation for the different meat types are in the range of .08 and .17. When analyzing the coefficients of variation of the different expenditures shares across months, beef shows the lowest seasonal variation with coefficient of variation of .073.These coefficients of variation range between .034 and .12 when considered annually. Relative variations in the beef share of total expenditures are about three times lower than observed with fish. Variation among the households buying different types of meat over time is presented in Figure 3.5. Seasonality is present as already shown in Figure 3.3. Seasonality is representative of household behavior where purchasing patterns differ cyclically. Poultry expenditures are closely tied with increases seen during November and December or Thanksgiving, and with cultural events, customs and special occasions. Such seasonality is most apparent for Christmas holidays.

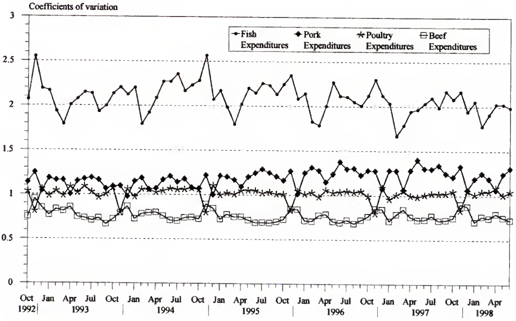

Figure 3.5: Distribution of the coefficients of variation among different households along different time periods (waves).

<u>Descriptive Statistics of Price</u>

Figure 3.6 shows the distribution of the average price of the different meat types over the 1992:10-1998:4 period. Relative price variations measured with the coefficients of variation are in the range between .05 and .09. The greatest differences in the coefficients of variation are seen among poultry and beef, with variations in the average price of poultry being 1.6 times that observed for beef. In Table 3.11 the average price for the different meat types across the different regions (east,

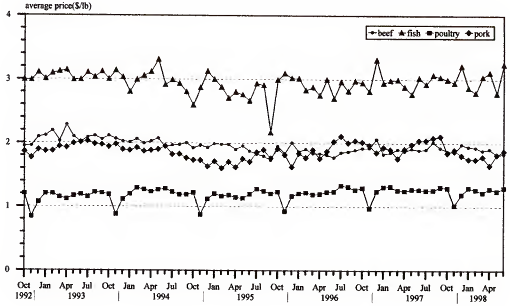

Figure 3.6: Distribution of average price of the different meat types along the time.

central, south, west) is presented. Meat prices differ across the census regions with fish showing the highest values, followed by beef, pork, and poultry.

Table 3.11: Average household purchasing prices for the different meat types across the different census regions.

Meat types	Census Regions				
	all	east	central	south	west
	--------------	-------------$	---per pound	--------------	--------------
Beef	1.950	2.126	1.845	1.933	1.939
Fish	2.953	3.160	2.812	2.881	2.992
Poultry	1.199	1.268	1.221	1.152	1.173
Pork	1.867	2.047	1.798	1.810	1.896

Descriptive Statistics of Other Variables

In order to measure the impact of health concerns on the buying behavior, cholesterol and fat index will be incorporated into the model development on section four. The econometrics estimates obtained will help on the analyze of the linkage between health issues and household purchase of a certain type of meat or beef. Figure 3.7 presents the distribution of households health concerns along the different quarters from 1992 until 1997, specifically the percent of households reporting completely or moderately agree with cholesterol and fat concern. Consumers concerns about fats and cholesterol slightly decreased from 1992 to 1997. These trends indicate that consumes concerns are higher for fat in comparison with cholesterol.

The impact of generic promotions on beef will also be evaluated on section four with the use of expenditure allocation models. Quarterly expenditures on beef promotions and advertising from 1992 until 1997 are shown in Figure 3.8. Expenditures on beef promotions are slightly higher than expenditures on advertizing.

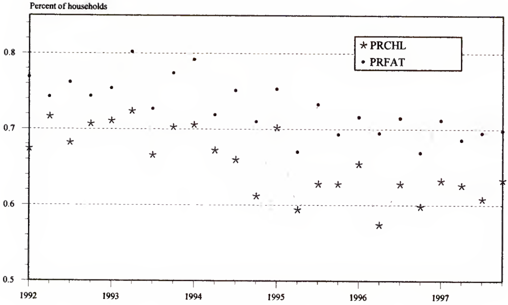

Figure 3.7: Distribution of health concerns (cholesterol and fat) along the different quarters from 1992 until 1997.

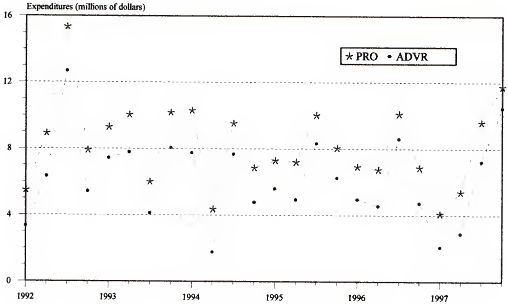

Figure 3.8: Distribution of quarterly expenditures on beef promotions and advertising from the first quarter of 1992 until the last quarter of 1997.

CHAPTER 4
MODEL DEVELOPMENT AND ESTIMATION PROCEDURES

In Chapter 2 several types of empirical demand systems were described with alternative specifications and functional forms implied for the utility function. Market share changes among different types of meat and cuts can be evaluated using one or more of the share models based on expenditure allocations. The different types of expenditure allocation models can be used to estimate demand for consumption goods including Linear Expenditure Systems (Stone, 1954), the Rotterdam Model (Theil, 1965; Barten 1969), Translog Models (Christensen, Jorgenson, and Lau, 1975), and an Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer, 1980). Among these, the AIDS model is one of the most widely used. This chapter includes the specification and estimation of the AIDS model. The effects of demographics, seasonality, promotions and health concerns are also incorporated into the model development. Details on how the AIDS model is to be used are set forth including the derivation of elasticities and demographic response procedures. The purpose of this chapter is to set forth the procedures, then Chapter 5 will be dedicated to the empirical estimation and related empirical results.

Model Specification

The Almost Ideal Demand System (AIDS) model was first suggested by Deaton and Muellbauer (1980) and is built on Stone's (1954) systems approach. The AIDS model incorporates assumptions of neoclassical demand theory and is easy to estimate in comparison with the linear

expenditure system and the Translog model preserving the generality of both Rotterdam and Translog models. In the AIDS model the budget shares of the various commodities are related to the logarithm of total expenditure and the logarithms of relative prices. The AIDS model satisfies the axioms of choice exactly, aggregates perfectly over consumers, gives an arbitrary first order approximation to any demand system, and can be used to test for homogeneity and symmetry.

Among the different expenditure allocation models, the AIDS model was selected for the current study due to the large number of properties it possesses. The AIDS model has a functional form consistent with household budget data, is reasonably flexible and is consistent with demand theory. The AIDS expenditure or cost function was previously presented in Chapter 2 (2.34). The AIDS model for a particular household h in share form is given by :

$$(4.1) \qquad w_{ih} = \alpha_i + \sum_{j=1}^{n} \delta_{ij} \ln(p_{jh}) + \beta_i \ln(m_h / P_h)$$

where w_{ih} is the average budget share for the i^{th} commodity for the h^{th} household, p_{jh} is the price of the j^{th} commodity for the h^{th} household, and m_h is the total meat expenditure for the h^{th} household. P_h is a price index defined by:

$$(4.2) \qquad \ln(P_h) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln(p_{kh}) + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} \delta_{kj} \ln(p_{kh}) \ln(p_{jh})$$

For editorial convenience, the *t* notation accounting for the different time periods is dropped without any loss in the equation meaning. In a preliminary stage of this research, four commodities will be considered in the AIDS model: beef, poultry, pork and fish. Later, the model will also consider different beef cuts (roasts, steaks, ground beef and other cuts) and poultry cuts, namely chicken, turkey and other poultry cuts for a total of nine commodities. The complexity of the model increases exponentially as more commodities are added.

In this study, demographic, seasonality, promotion, and health concerns variables are incorporated into the AIDS model. Scaling and translating techniques allow the incorporation of these

variables into the direct utility function. Incorporation of demographic effects in demand systems dates from Barten (1964), Muellbauer (1977) and Pollak and Wales (1978, 1980, 1981). Pollak and Wales (1981) describe four different procedures for including demographic variables into complete demand systems: demographic translating, demographic scaling, Gorman specification, and the modified Prais-Houthakker procedure. In all of these cases the demand systems describe the allocation of expenditure among a number of consumption categories. Each procedure replaces the original class of demand systems by a related class involving additional parameters and postulates that only these additional parameters depend on the demographic variables. Due to simplicity and flexibility reasons, this study employs the use of demographic translating as part of the AIDS model specification. According to Pollak and Wales (1981), translating allows subsistence parameters of demand systems to depend on the demographic and other exogenous variables.

The Almost Ideal Demand System (AIDS) in share form including demographics, seasonality, health and promotional effects is given by:

(4.3) $$w_{ih} = \alpha_i + \sum_{r=1}^{4} \Theta_{irh} + \sum_{j=1}^{4} \delta_{ij} \ln(p_{jh}) + \beta_i \ln(m_h / P_h)$$

with the price index, P_h defined as:

(4.4) $$\ln P_h = \alpha_0 + \sum_{k=1}^{4}\left(\alpha_k + \sum_{r=1}^{4} \Theta_{irkh}\right) \ln(p_{kh}) + \frac{1}{2} \sum_{k=1}^{4}\sum_{j=1}^{4} \delta_{kj} \ln(p_{kh}) \ln(p_{jh})$$

where Θ_{irh} includes demographic, seasonality, promotional, and health effects. The demographic effects include household size, age of female, female employment level, female education level, census region, and market size. These are expressed as:

$$
\begin{aligned}
\Theta_{i1h} &= \lambda_{i1}(HSZ_1 - HSZ_4) + \lambda_{i2}(HSZ_2 - HSZ_4) + \lambda_{i3}(HSZ_3 - HSZ_4) \\
&+\lambda_{i4}(AGF_1 - AGF_3) + \lambda_{i5}(AGF_2 - AGF_3) + \lambda_{i6}(EMF_1 - EMF_3) \\
&+\lambda_{i7}(EMF_2 - EMF_3) + \lambda_{i8}(EDF_1 - EDF_3) + \lambda_{i9}(EDF_2 - EDF_3) \\
&+\lambda_{i10}(STA_1 - STA_4) + \lambda_{i11}(STA_2 - STA_4) + \lambda_{i12}(STA_3 - STA_4) \\
&+\lambda_{i13}(MSA_1 - MSA_3) + \lambda_{i14}(MSA_2 - MSA_3)
\end{aligned} \tag{4.5}
$$

where each of the demographic variables is compared to an average household. The different coefficient estimates measure the deviation of each of the demographics from an average household. The seasonality effect can be expressed as:

$$
\begin{aligned}
\Theta_{i2h} &= \mu_{i1}(QTR_1 - QTR_4) + \mu_{i2}(QTR_2 - QTR_4) \\
&+\mu_{i3}(QTR_3 - QTR_4)
\end{aligned} \tag{4.6}
$$

where each quarter is compared to an average demand over the all year for an average household. Each demographic or seasonality variable is defined in such a way that the sum of the coefficients for that particular variable is set to zero. For example at the demographic household size, the four household size coefficients are summed to zero. Then each household size coefficient is estimated where: household size with 1 member (HSZ_1): $\alpha_k+\lambda_{i1}$; household size with two members (HSZ_2): $\alpha_k+\lambda_{i2}$; household size with three members (HSZ_3): $\alpha_k+\lambda_{i3}$; and household size with four or more members (HSZ_4): $\alpha_k-\lambda_{i1}-\lambda_{i2}-\lambda_{i3}$. Hence, α_k represents an overall average across household sizes instead of just one of the four household sizes.

Each demographic or similar variable is binary (see Table 3.3) and is usually represented by three or four dummy variables depending on the number of characteristics. For instance HSZ_1, HSZ_2, HSZ_3 and HSZ_4 are dummy variables for household size (1 member, 2 members, 3 members, 4 or more members). AGF_1 and AGF_2 are dummy variables for age of female (under 29 years old and from 30 to 49 years old) while AGF_3 is for those females with 50 years or older. Female employment level is represented by EMF with EMF_1 accounting for unemployed households, EMF_2 for households working under 30 hours per week and EMF_3 for those with full time employment. The three dummies for female education level are EDF_1 (high school education), EDF_2 (college education), and EDF_3

(post college graduate) and the four dummies for region are: STA_1 (east), STA_2 (central), STA_3 (south), and STA_4 (west). MSA_1 represents regions with under 50,000 people, MSA_2 regions with 50,000 to 249,999 people, and MSA_3 regions with over 250,000 people. Age and presence of children in the household are accounted for with the household size and age of female variables (see Chapter 3).

The health effects can be expressed by the cholesterol concern (see Chapter 3) expressed by the households:

$$(4.7) \qquad \Theta_{i3h} = \varepsilon_1 PRCHL$$

where PRCHL represents the percentage of households that completely or moderately agree with cholesterol concern.

Promotional and advertizing effects are introduced as shown in equation (4.8). Square roots of the promotion and leading national advertisers variables are used in the assumption that these impacts increase at a decreasing rate:

$$(4.8) \qquad \begin{aligned} &\Theta_{i4h} = \gamma_{i1} PROM^{.5} + \gamma_{i2}(LNA\#PK)^{.5} + \\ &\gamma_{i3}(LNA\#PL + LNA\#TK)^{.5} \end{aligned}$$

with PROM representing quarterly expenditures on beef promotions; LNA#PK is advertising expenditures on pork; LNA#PL is advertising expenditures on chicken; and LNA#TK is advertising expenditures on turkey.

Household consumption behavior is expected to be profoundly different across income groups. Hence rather than including income as another demographic variable, the data are separated into four income groups and then an AIDS model is estimated for each income category. In this way all coefficients can differ across income groups. In addition, in the AIDS model specification, the meat expenditures are responsible for measuring the income effect. Income is not included as another demographic variable since most of the income effect should be embedded in the total meat

expenditure variable. As meat expenditures increase with the income level of the household, different purchase behavior also occurs across income groups. Unlike other demographics, in the AIDS model specification, income is a constraining factor in terms of household behavior. The AIDS model estimation for each income category is this way justified since all coefficients, and particularly the demographics, can differ across these income groups. Non linear estimation for each income group is based on maximum likelihood techniques using the four income groups ranging from under $25,000 a year to over $75,000 a year.

AIDS model coefficients are estimated and demand elasticities derived with the more important responses including expenditure elasticities, compensated and uncompensated price elasticities, price share elasticities, and expenditure share elasticities. When the price of a commodity goes up, real income actually decreases and the term uncompensated simply means that the measured price effect includes both price and income components. Compensation implies that the demand is estimated after adjusting income to bring real income back to the level before the price change. Hence, compensated demand elasticity offers a true measure of the relationship between prices and quantities demanded. Effects from incorporating different demographics, seasonality, promotion, health index and advertising variables on the different commodity budget shares can be evaluated. In this way, the model provides an indication of the response of the budget shares to changes in these variables. For example, if the number of women employed increases, the allocation of expenditures among the different types of products can be shown. Similarly the responses can be simulated across each of the four income groups.

Demand Elasticities

A demand function can be described by its elasticity values where demand elasticity is a measure of the relative responsiveness of the quantity purchased to changes in prices. The elasticity of demand gives the percentage change in the quantity demanded of a good from a one percent change (increase or decrease) in the price of that good. In demand theory, there are several types of elasticities such as: own-price, cross-price, and budget (income) elasticities. The own elasticity of demand measures the relationship between the price of a good and its quantity demanded, while the cross price elasticity of demand relates the percentage change in the quantity of one good to a percentage change in the price of the other good. Income elasticity of demand measures the percentage change in the purchases of a commodity relative to the change in income. For a given demand function $x_i = f_i(p, m)$, these elasticities were previously defined in Chapter 2 (2.4), (2.5) and (2.6). Compensated demand takes into account the change in real income when the price of a commodity goes up. The nonlinear AIDS elasticities can be derived from (4.3) both theoretically as shown below and empirically after the models are estimated.

Own Price Uncompensated Elasticity of Demand

The expression for own price uncompensated elasticity of demand can be obtained by taking the partial derivative of (4.3) with respect to p_i after replacing (4.4) into (4.3). In this case p_j replaces p_i.

(4.9) $$\frac{\partial w_i}{\partial p_i} = \frac{(\delta_{ij} - \beta_i \phi_i)}{p_i}$$

where

(4.10) $$\phi_i = \alpha_i + \sum_{r=1}^{4} \Theta_{ir} + \sum_{j=1}^{n} \delta_{ij} \ln(p_j)$$

For editorial convenience, the *t* notation accounting for the different time periods, and the h notation accounting for the hth household will be dropped from the subscripts without any loss in the interpretation.

Taking into account the definition of expenditure shares, $w_i = (p_i x_i)/m$, and the definition of the own price elasticity, $\epsilon_{ii} = (p_i/x_i)(\partial x_i/\partial p_i)$, then:

(4.11) $$\frac{\partial\left(\frac{p_i x_i}{m}\right)}{\partial p_i} = \frac{p_i}{m}\frac{\partial x_i}{\partial p_i} + \frac{x_i}{m} = \frac{1}{m}\left(x_i + \frac{\partial x_i}{\partial p_i} p_i \frac{x_i}{x_i}\right) = $$
$$= \frac{1}{m}\left(x_i + x_i \varepsilon_{ii}\right) = x_i (1 + \varepsilon_{ii}) \frac{1}{m}$$

Expressions (4.9) and (4.11) are equal.

(4.12) $$x_i (\varepsilon_{ii} + 1)\frac{1}{m} = \frac{(\delta_{ij} - \beta_i \phi_i)}{p_i}$$

Multiplying both sides of (4.12) by p_i/w_i then gives:

(4.13) $$w_i (\varepsilon_{ii} + 1)\frac{1}{w_i} = \frac{(\delta_{ij} - \beta_i \phi_i)}{w_i}$$

The expression for the own price uncompensated elasticity of demand immediately follows:

(4.14) $$\varepsilon_{ii} = \frac{(\delta_{ij} - \beta_i \phi_i)}{w_i} - 1$$

with ϕ_i being represented by (4.10).

Cross Price Uncompensated Elasticity of Demand

The cross price uncompensated elasticity of demand can be obtained by a similar way to the own price uncompensated elasticity of demand. Taking the partial derivative of (4.3) with respect to p_j, after replacing (4.4) into (4.3):

(4.15) $$\frac{\partial w_i}{\partial p_j} = \frac{(\delta_{ij} - \beta_i \phi_i)}{p_j}$$

where ϕ_i is given by expression (4.10). Expression (4.9) now becomes:

(4.16) $$\frac{\partial(\frac{p_i x_i}{m})}{\partial p_j} = \frac{p_i}{m}\frac{\partial x_i}{\partial p_j} = \frac{1}{m}\left(\frac{\partial x_i}{\partial p_j} p_i\right) = \\ = \frac{1}{m}\left(\frac{\partial x_i}{\partial p_j} p_i \frac{x_i}{x_i}\frac{p_j}{p_j}\right) = \frac{1}{m}\left(\varepsilon_{ij}\frac{p_i x_i}{p_j}\right)$$

Multiplying (4.16) and the right hand side of (4.15) by p_j/w_i yields:

(4.17) $$\frac{p_i}{w_i}\frac{1}{m}\left(\varepsilon_{ij}\frac{p_i x_i}{p_j}\right) = \frac{\delta_{ij} - \beta_i \phi}{p_j}\frac{p_i}{w_i}$$

The expression for the uncompensated cross price elasticity of demand is then:

(4.18) $$\varepsilon_{ij} = \frac{(\delta_{ij} - \beta_i \phi_i)}{w_i}$$

with ϕ_i being represented by (4.13).

Compensated Elasticity of Demand

The own price compensated elasticity of demand can be obtained from the own price uncompensated elasticity of demand:

(4.19) $$\varepsilon_{ii}^{*} = \varepsilon_{ii} + w_i \eta_i$$

The cross price compensated elasticity of demand can be obtained from the cross price uncompensated elasticity of demand:

(4.20) $$\varepsilon_{ij}^{*} = \varepsilon_{ij} + w_i \eta_j$$

Expenditure Elasticity of Demand

The expenditure elasticity of demand can be obtained by taking the partial derivative of (4.3) with respect to income, m:

(4.21) $$\frac{\partial w_i}{\partial m} = \frac{\beta_i}{m}$$

Knowing that the expenditure share spent in good i, $w_i = (p_i\, x_i)/m$, the left hand side of (4.21) becomes:

(4.22) $$\frac{\partial\left(\frac{p_i x_i}{m}\right)}{\partial m} = \frac{\frac{\partial(p_i x_i)}{\partial m} m - p_i x_i \frac{\partial m}{\partial m}}{m^2} = \frac{m\left(\frac{\partial p_i}{\partial m} x_i + \frac{\partial x_i}{\partial m} p_i\right) - p_i x_i}{m^2}$$

Being $\partial p_i / \partial m = 0$ the expression (4.22) becomes:

(4.23) $$\frac{\frac{\partial x_i}{\partial m} p_i \frac{x_i}{x_i} m - p_i x_i}{m^2}$$

Knowing the expression for income elasticity, $\eta_{im} = (m/x_i)\,(\partial x_i/dm)$, and multiplying (4.23) by x_i/x_i yields:

(4.24) $$\frac{p_i x_i(\eta_i - 1)}{m^2}$$

Expressions (4.24) and the right hand side of (4.21) are equal.

(4.25) $$\frac{w_i(\eta_i - 1)}{m} = \frac{\beta_i}{m}$$

An expression for the expenditure elasticity of demand is then:

(4.26) $$\eta_i = 1 + \frac{\beta_i}{w_i}$$

Share Elasticities

The expression for the expenditure share elasticity of demand can be obtained by taking the partial derivative of (4.3) with respect to m:

(4.27) $$\frac{\partial w_i}{\partial m} = \frac{\beta_i}{m}$$

Multiplying both sides of this expression by m/w_i:

(4.28) $$\frac{\partial w_i}{\partial m}\frac{m}{w_i} = \frac{\beta_i}{m}\frac{m}{w_i}$$

the expenditure share elasticity is obtained:

(4.29) $$\eta_i^w = \frac{\beta_i}{w_i}$$

In order to obtain the price share elasticity, the partial derivative of (4.3) with respect to price is first taken:

(4.30) $$\frac{\partial w_i}{\partial p_j} = \frac{(\delta_{ij} - \beta_i \phi_i)}{p_j}$$

and:

$$\frac{\partial w_i}{\partial p_j} = \gamma_{ij} \frac{p_i x_i}{m} \frac{1}{p_j} \tag{4.31}$$

Multiplying (4.30) and (4.31) by p_j/w_i results in the following:

$$\gamma_{ij} \frac{p_i x_i}{m} \frac{p_j}{p_j w_i} = \frac{(\delta_{ij} - \beta_i \phi_i)}{p_j} \frac{p_j}{w_i} \tag{4.32}$$

$$\gamma_{ij} = \frac{(\delta_{ij} - \beta_i \phi_i)}{w_i} \tag{4.33}$$

Estimation Issues Associated with the AIDS model

There are several data and estimation issues associated with using the AIDS model. A schematic representation of issues when dealing with this type of expenditure allocation model is presented in Figure 4.1.

The panel data used in this study consists of time series observations on each of several cross sectional units. Pooling cross sectional and time series data in the model should not present a problem given that household differences are captured with demographics and seasonality. Furthermore, the models are separated into income groups before being estimated. Also, the number of time units changes across households since every household does not consistently reports each period. The AIDS model will be first estimated for the four meat cuts that include beef, poultry, pork and fish and, secondly, taking into account the different beef and poultry cuts. This way, nine products will be considered: roasts, steaks, ground beef, other cuts, chicken, turkey, other types of poultry, pork and fish. The data used in the AIDS model either including four or nine products can appear in 3 different

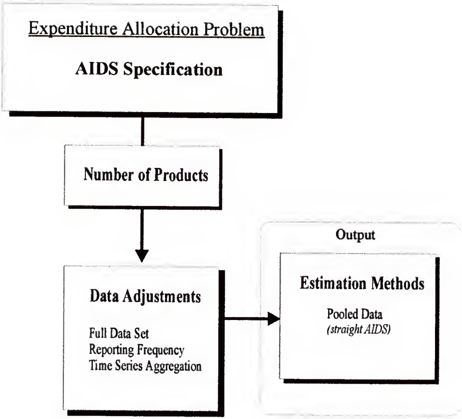

Figure 4.1: Schematic representation of estimation issues with the AIDS model.

ways. First estimates can be obtained using the full data set (68,844 observations). Second the AIDS model can be estimated according to the frequency that households report. For example, the models can be based on households that report at least twice. Third the data could be aggregated by quarters. This way the data would be arranged by household and quarter with each household entry showing the purchases of each type of meat in a quarter. This aggregation by quarter would make sense as some of the data used in this study, (i.e., promotion, advertising and health) were reported on a quarterly basis.

Estimation will be done using a pooled straight AIDS model without using the Stone's index approximation. This type of model was already discussed in the previous section.

One of the problems in the model estimation is how to deal with missing prices for households that did not purchase meat products during the period of the survey. When a household expenditure on a particular product is zero, the price for that product in that specific period cannot be determined. In general, zero expenditures are recorded because some households choose simply not to purchase the product in a particular period while some households may never buy the product. When the households expenditures are zero, an average price is determined for each meat type by year and quarter and then included as a proxy price when the price is not reported.

Model Estimation

This study will concentrate on the AIDS model using the pooled data over the quarterly time series and households. The AIDS model will be estimated without using the Stone's price index approximation. That is, equation (4.2) is directly included in (4.1). In the estimation of the AIDS model, different scenarios will be considered taking into account the number of meat products considered in the study, the consumption of all meat products during a particular time period, the number of times an individual household reports and the time of the survey. These different scenarios facilitate comparing different household consumption possibilities. The AIDS model can be estimated taking into account the four meat cuts that include beef, poultry, pork and fish and/or considering the different beef and poultry cuts for a total of nine products. It is assumed that households can either consume all or any of the meat products in the same time period. From the data set, 26.3 percent of the households consumed all four meat products in the same time period.

Households will be assumed to report either at least one or two times during the reporting period (see Chapter 3).

In terms of consumption levels of different types of meat, there are outliers in the data set as seen with the pounds reported within a particular period. In order to evaluate these outliers, household consumption levels, expressed in pounds of different types of meat products, were determined for each quarter. Outliers in the range of 100 pounds to 800 pounds occurred in the data set. Figure 4.2 is used to show the reasonable range of household consumption levels. Figure 4.2 shows the number of observations in the data base and the percent of these observations (37,866) reporting given pounds of consumption. For example, ninety eight percent of the observations included households buying under 50 pounds of meat within one quarter. Based on this results, it is assumed that the maximum quantity of meat consumed by households during the time of the survey

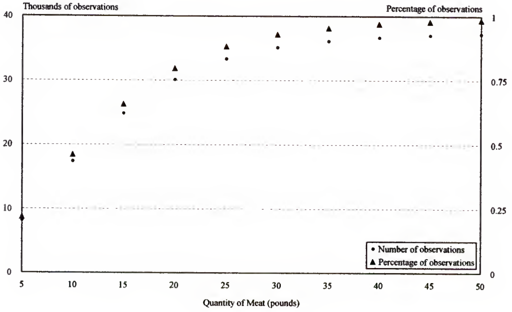

Figure 4.2: Distribution of the number of observations across the quantity of meat purchased.

is 50 pounds. Values above 50 pounds are considered outliers and are excluded from the estimation. Even with these exclusions, all models include at least 98 percent of the original data.

The different scenarios that will be considered in the estimation of the AIDS model are:

Scenario (1). The number of products consumed is four, defined as beef, fish, poultry and pork. The maximum quantity of meat consumed by a household is 50 pounds and households may consume any combination of the meat products during a certain time period. Households are reporting at least one time during a quarter. The data considered range from the last quarter of 1992 through the last quarter of 1997.

Scenario (2). The number of products consumed by the household is nine, taking into account the different beef and poultry cuts. It includes roasts, steaks, ground beef, other cuts, chicken, turkey, other poultry cuts, pork, and fish. The maximum quantity of meat consumed by the households is 50 pounds and households may consume any combination of the four meat products during a certain time period. Households are reporting at least one time during a quarter. The data considered range from the last quarter of 1992 through the last quarter of 1997.

Scenario (3). Four products are taken into account with a maximum quantity consumed of 50 pounds. Households report at least one time during a quarter, all meat products are consumed by the household during the same period, and the data set ranges from the last quarter of 1992 through the last quarter of 1997.

Scenario (4). Same as scenario (3), but instead of four products, nine products are considered.

Scenario (5). Four products are taken into consideration, with a maximum quantity consumed of 50 pounds. Households report at least two times during a quarter and any combination of the meat products are consumed in the same time period. The data ranging from the last quarter of 1992 until the last quarter of 1997 is included.

Scenario (6). Same as scenario (5), but instead of four products, nine products are considered.

Scenario (7). Number of products taken into account is four, with a maximum quantity consumed by the households of 50 pounds. Households report at least two times during a quarter and the four meat products are consumed in the same time period. The whole data ranging from the last quarter of 1992 through the last quarter of 1997 is included in this analysis.

Scenario (8). Same as scenario (7), but instead of four products, nine products are considered.

The eight different scenarios that will be considered in the estimation of the AIDS model are summarized in Table 4.1.

Table 4.1: Different scenarios used in the estimation of the AIDS model.

Scenarios	Number of Products	Pounds limit	Time period	All meat products	Number of reporting times
1	4	50	1992-->1997	no	>=1
2	9	50	1992-->1997	no	>=1
3	4	50	1992-->1997	yes	>=1
4	9	50	1992-->1997	yes	>=1
5	4	50	1992-->1997	no	>=2
6	9	50	1992-->1997	no	>=2
7	4	50	1992-->1997	yes	>=2
8	9	50	1992-->1997	yes	>=2

For each scenario, the AIDS model is estimated across the four income groups: under \$25,000; between \$25,000 and \$49,999; between \$50,000 and \$74,999; \$75,000 and over.

Shares Derivation from Demographics

The different demographic variables and seasonality are expected to have an impact on the budget shares. Specifically, they may influence the allocation of consumer expenditure shares among the different meat types and product forms. Demographics are measured with household sizes, ages of females, employment of females, education of females, census regions and market sizes. Female demographics are expected to be important since food purchasing decisions are often made by females. Using the coefficient estimates and equation (4.3), the budget shares of the different meat products are estimated at the mean values of price and total meat expenditures for all the demographics. For instance, at the household size, there are four different categories: one member, 2 members, 3 members and 4 or more people in the household. For this range, the budget shares of either the four meat products or the nine meat products were determined for each scenario, taking into account the four different income levels. This will allow a comparison among the budget shares for different household sizes, across the four income levels: under $25,000; $25,000 to $50,000, $50,000 to $75,000 and over $75,000 for each meat product. Similar comparisons are made for all the demographics.

Based on the elasticities expressions previously defined, uncompensated, compensated and expenditure demand elasticities are determined in the different scenarios for all the demographics. This way, there will be elasticities at the mean price and total expenditure level for the different demographic ranges.

Ranking Demand Shifters

Table 3.3 set forth major demographic and other variables expected to have an impact on the demand for different meat products. Using equation (4.5) each demographic was represented with a number of binary variables using the restriction that the sum of the coefficients for each demographic equal zero. This procedure is useful in that the impact from changing any combination of demographics can be expressed relative to the average consumer. For example, let's suppose that the share for beef (w_1) is derived from the AIDS model. For the average consumer let the share be w_1^0. Considering any particular demographic variable over the range from the lowest to the highest value, the new share is expressed as w_1^j where j=1,2,... depending on the number of binary variables needed to reflect a specific demographic factor. Each w_1^j is expressed relative to w_1^0 or $R_1^1 = w_1^1 - w_1^0$. This way the R values are comparable within a particular demographic as well as across demographics since in every case they are relative to the same base, the average household. For each demographic variable, it is useful to show the range of impact from the lowest to the highest values of the demographic where $\Delta_1 = |R_1^3 - R_1^1|$ assuming three discrete variables for a particular demographic factor. In order to show the ranking across the different demographics, namely the ones presenting the higher impact and the ones having the lower impact on the budget shares of a certain meat product, the Δ values were ranked. This way the demographics and other factors can be put into perspective to show what is really driving the demand for each meat product and the direction of change. It provides a ready tool for predicting change and to identify which markets should be targets if an industry wants to address negative effects.

In this chapter the AIDS model in share form including demographics, seasonality, health and promotional effects is specified. Different types of demand elasticities were also presented, including own and cross price either uncompensated or compensated, expenditure and share elasticities.

Estimation issues associated with the model and different estimation procedures were discussed, including the derivation of the meat budget shares from the demographic variables. In Chapter 5, the coefficient estimates obtained from the AIDS model are reported for the four and nine meat products under the four income categories.

CHAPTER 5
ECONOMETRICS ESTIMATES

The results and analyses from the expenditure allocation models (AIDS models) are summarized in this chapter. This study concentrates on a pooled AIDS model estimated over the time series using a quarterly aggregated data set. The AIDS model (equation 4.3 from Chapter 4) is estimated for the different meat products under the different scenarios (see Table 4.1 in Chapter 4) without the Stone's price index approximation. In each of the scenarios four different income groups are considered. AIDS models are estimated for either four meat products, including beef, poultry, pork and fish (Appendix A) or for nine meat products including the different beef and poultry cuts: roasts, steaks, ground beef, other beef cuts, chicken, turkey, other poultry cuts, pork and fish (TSP, 1998). In any of these cases one equation is dropped in the estimation due to the adding up property of the AIDS model where the sum of the budget shares must equal one as explained in Chapter 2. For the scenarios based on four meat products, there will be twelve independent equations accounting for the four income groups. For the scenarios including nine meat products, eight independent equations for each income group will give a total of thirty two independent equations. All parameters under the different scenarios were estimated using the imposed demand conditions for the AIDS model (see Chapter 2). Standard errors immediately follow from the variance-covariance matrix of estimated parameters. For convenience, t-values instead of the standard errors are reported. Correction for heterocedasticity using the White's test was performed in the determination of the different parameters and supporting statistics. The explanation of this test can be found in Greene (1997). The AIDS model was estimated for the eight different scenarios previously described in Chapter 4. For

each scenario, the AIDS model was estimated across the four income groups: under $25,000; between $25,000 and $49,999; between $50,000 and $74,999 and $75,000 and over.

Later in this chapter a comparison among the different scenarios will be made. Sensitivity analyses will show no difference in terms of market shares among the scenarios involving four meat products and within the scenarios involving nine meat products. Only the parameter estimates from scenarios 1 and 2 will be shown as reported in Tables 5.1 through 5.8. A total of a hundred and eight estimates was obtained for each income group in the case of scenario 1 and two hundred and forty three different estimates were obtained for the nine meat products (scenario 2) and for each income group.

At the bottom of each table, the number of observations used in the final estimation and the likelihood values are shown. The panel data used in this study consists of time series observations on each of several cross section units. Pooling cross sectional and time series data in the model should not present a problem given that household differences are captured with demographics and seasonality. Also, the number of time units changes across households since every household does not consistently reports each period. Using the R-square as a quasi-measure of goodness-of-fit, this statistic shows the amount of variation explained to be quite low under the different income groups (Tables 5.1 through 5.8). While a higher goodness-of-fit would be preferred, these low values are typical when using large pooled data sets. Due to the high number of cross sections present in the data set, a large portion of randomness is not picked up by the demographics and other variables. In addition, the amount of variation is accentuated in the AIDS model specification.

The different model coefficients can be divided into six groups: demographic effects, seasonality effects, health effects, promotional and advertizing effects, price effects, and expenditure effects. With respect to the impact of the different demographic variables on the budget shares, the empirical results generally conform to a priori expectations. The demographic effects include six

different categories: household size, age of female, female employment level, female education level, census region and market size. Demographic effects were incorporated according to equation (4.5) from Chapter 4. In Tables 5.1 through 5.4, λ_{ij} are demographic coefficients where i=1, 2 , 3 and 4 (i.e., 1=beef, 2=poultry, 3=pork and 4=fish), and j=1, 2, ..., 14 (i.e., 1=household size of one member, 2= household size with two members, 3= household size with three members, 4= females with 29 years or under, 5= females with ages between 30 and 49 years, ..., 13=areas with less than 50,000 people, 14=mid-sized cities of 50,000 to 250,000 people). For each of the different demographics the sum of the coefficients were restricted to zero. In this way, it is possible to analyze the demographic effects from the perspective of an average household (see Chapter 4). In case of scenario 2, λ_{ij} also accounts for the different demographic coefficients, but because there are nine products being analyzed, i can go from 1 to 9, with (1=roast, 2=steak, 3=other beef, 4=ground beef, 5=chicken, 6=turkey, 7=other poultry, 8=pork and 9=fish).

Empirical Results from Scenario 1

Maximum likelihood procedures were used to estimate the AIDS model and the resulting parameters and supporting statistics are reported in Tables 5.1 through 5.4 with the estimates corresponding to the coefficients from equation (4.3). The number of iterations before convergence was achieved, ranged between 3 and 5 among the four income categories. The number of observations used for the estimation of the different AIDS models differed across income groups. The higher number of observations used in the estimation occurred within the income groups of under \$25,000 and from \$25,000 to \$50,000, with 10705 and 10200 observations respectively. In Tables 5.1 through 5.4, it can be seen that the majority of the demographic coefficients are statistically significant. In order to illustrate this, an example for the household size effect on the different meat budget shares

for households with an income level under $25,000 (Table 5.1) is considered. The effect of households with one, two and three members when compared to an average household are not statistically significant when looking at the beef estimates. On the other hand side, households with two members have a statistically positive coefficient for pork. For the effect of household size on beef budget shares for different income levels, the income group between $25,000 and $49,999 presents two household size levels statistically significant and different from an average household. For all the income groups, the effect on poultry budget shares of households either under 29 years old or between 30 and 49 years old is close to that of an average household and not significant. In case of the income group between $25,000 and $49,999, the effect of age of female on beef shares is

Table 5.1: AIDS estimates for meat products for income under $25,000 (scenario 1).

	Beef		Poultry		Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.38160	4.86191	0.54942	7.34488	0.00229	0.035276	0.06669	1.34598
λ_{i1}	-0.00566	-.916035	-0.01204	-1.98471	-0.00080	-0.154937	0.01850	4.90074
λ_{i2}	-0.00144	-.329098	-0.01305	-3.17338	0.01134	3.13873	0.00316	1.19211
λ_{i3}	0.00362	.673750	0.00506	1.02355	0.00499	1.17104	-0.01367	-4.35603
λ_{i4}	0.02326	3.79710	-.00245	-0.431735	-0.02492	-5.61905	0.00411	1.06818
λ_{i5}	0.00641	1.40356	0.00540	1.25969	-0.00793	-2.25693	-0.00387	-1.38452
λ_{i6}	0.00080	.191844	0.00827	2.06448	-0.00567	-1.66416	-0.00340	-1.34232
λ_{i7}	-0.00807	-1.33719	0.00768	1.29863	-0.00359	-0.733365	0.00398	1.04217
λ_{i8}	0.03487	4.85910	-0.06623	-7.55158	0.02870	4.34040	-0.00094	-0.202591
λ_{i9}	0.00510	.622655	-0.00420	-.465908	-0.00221	-0.326123	0.00131	0.264743
λ_{i10}	-0.03632	-7.09314	0.02366	4 70724	-0.00438	-1.00444	0.01703	4.73689
λ_{i11}	0.00189	.403604	-0.01721	-3.88229	0.03304	8.46948	-0.01772	-6.46835
λ_{i12}	0.00456	1.09344	0.01052	2.62456	-0.00573	-1.71033	-0.00935	-3.67559
λ_{i13}	0.00767	1.73286	-0.00017	-0.040901	0.00571	1.52685	-0.01321	-5.32924
λ_{i14}	-0.00306	-.518195	-0.01049	-1.84402	0.01262	2.49702	0.00093	0.260891
μ_{i1}	0.00913	1.61976	-0.01104	-2 06275	-0.01184	-2.52357	0.01374	3.88411
μ_{i2}	0.00996	1.93714	-0.01512	-3.13406	0.00464	1.10051	0.00053	0.165422
μ_{i3}	0.02462	4.65247	-0.01680	-3.39873	-0.00892	-2.0793	0.00110	0.338650
ϵ_{i1}	-0.18001	-2.2061	-0.02466	-0.31578	0.26382	3.86511	-0.05915	-1.19175
γ_{i1}	0.00904	.954785	-0.00821	-.900484	-0.00205	-.259601	0.00121	0.215687
γ_{i2}	0.00003	.082514	-0.00034	-.87724	-0.00001	-0.036562	0.00032	1.33318
γ_{i3}	0.00092	2.82367	-0.00022	-.736786	-0.00047	-1.74364	-0.00023	-1.11920
δ_{i1}	-0.02265	-2.79009	-0.01758	-3 43654	0.02595	4.53625	0.01428	3.25058
δ_{i2}	-0.01758	-3.43654	0.02585	4.24809	-0.02024	-4.70589	0.01197	3.73838
δ_{i3}	0.02595	4.53625	-0.02024	-4.70589	0.00035	0.049890	-0.00606	-1.57167
δ_{i4}	0.01428	3.25058	0.01197	3.73838	-0.00606	-1.57167	-0.02020	-3.89412
β_i	0.00136	.335283	-0.05419	-14.0899	0.02577	8.04502	0.02706	11.5572

Number of observations = 10705 Log likelihood = 5726.98 * Table t at 5% = 1.96
R-Sq (equation 1) = .029237 R-Sq (equation 2) = .057683 R-Sq (equation 3) = .052111

statistically significant. For beef and all income groups, except the one from \$49,999 to \$75,000, female employed part time is not statistically significant from an average household. For poultry and pork, coefficients for females having a high school education level relative to a household with an average education level are statistically significant. The effect on poultry shares is negative, while the effect on pork shares is positive. Market size also has an influence on the meat shares. The effect of households living in regions with different number of people plays a role on the allocation of shares among different types of meat. There are also differences according to the various income groups.

Seasonality also presents an impact on the different meat shares across the four income groups. Seasonality effects (μ_{ij}) were expressed by equation (4.6) in Chapter 4. Each quarter is compared to an average demand over the all year for an average household. Seasonality seems to be particular important on the consumption of poultry, with significant coefficients across the four income groups.

The impact of health effects (ε_{ij}), beef promotions, and advertizing (γ_{ij}) on budget shares can also be determined. These effects were defined by expressions (4.7) and (4.8) in Chapter 4. Health concerns are seen to have an impact on consumer demand for beef and pork. Specifically, there seems to be a negative correlation between cholesterol concerns and beef demand. The promotions, while having the correct signs are not statistically significant. Using longer time series, Ward has shown the beef promotions to be effective. The lack of significance in this study is probably due to the shorter time period than used in most other beef promotion analyses (e.g., 1984 through 1997).

Price effects (δ_{ij}) indicate the impact of change in relative prices on the budget shares among the meat products. The majority of the price effects are significant at .05 percent level, indicating relationships between budget shares and prices. Differences in magnitudes and signs of the coefficients are present across the four income groups. In general the significance among the prices

increases with the higher income groups. Later price elasticities are shown to compare the differences among the income categories.

Table 5.2: AIDS estimates for meat products for income from $25,000 to $49,999 (scenario 1).

	Beef		Poultry		Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.43677	5.63285	0.45400	6.08710	0.12295	1.94157	-0.01372	-.255209
λ_{i1}	-0.06969	-7.81290	0.02608	2.72508	0.00694	0.876181	0.03666	5.20650
λ_{i2}	0.00407	0.798320	-0.01142	-2.29285	0.00852	2.01503	-0.00116	-0.312495
λ_{i3}	0.02766	5.10617	-0.01627	-3.13547	0.00053	0.118610	-0.01192	-3.14256
λ_{i4}	0.01849	3.14363	0.00224	0.402971	-0.02686	-6.34239	0.00614	1.50317
λ_{i5}	0.00203	0.470530	0.00282	0.701206	0.00157	0.487010	-0.00642	-2.25771
λ_{i6}	-0.00145	-0.379579	0.01586	4.38458	-0.01015	-3.31248	-0.00425	-1.63502
λ_{i7}	-0.00428	-0.874093	0.00701	1.51814	0.00014	0.034747	-0.00286	-0.903657
λ_{i8}	0.03944	8.15049	-0.05457	-10.6556	0.02291	5.78857	-0.00778	-2.04937
λ_{i9}	0.00772	1.64425	0.00278	0.553345	0.00018	0.046428	-0.01068	-2.83620
λ_{i10}	-0.03408	-7.58591	0.03120	6.97612	-0.01235	-3.39420	0.01523	4.35033
λ_{i11}	-0.00244	-0.497082	-0.02173	-4.76379	0.03283	8.21429	-0.00867	-2.81651
λ_{i12}	0.01302	3.11054	-0.00833	-2.11780	-0.00569	-1.71157	0.00101	0.354706
λ_{i13}	0.01533	3.02660	-0.01378	-3.01337	0.01216	2.99196	-0.01371	-4.50673
λ_{i14}	0.01083	1.72061	-0.00882	-1.53519	-0.00328	-0.671805	0.00127	0.316732
μ_{i1}	-0.00130	-0.238886	-0.01432	-2.84033	-0.00657	-1.51368	0.02219	5.72320
μ_{i2}	0.01769	3.50809	-0.01167	-2.47193	-0.00114	-0.285286	-0.00488	-1.46989
μ_{i3}	0.02793	5.41186	-0.00799	-1.66568	-0.01428	-3.59274	-0.00566	-1.64084
ϵ_{i1}	-0.13713	-1.70733	0.07547	0.981126	0.07253	1.12054	-0.01086	-0.205805
γ_{i1}	0.00193	.210905	-0.00824	-0.949204	0.00332	0.447075	0.00299	0.492182
γ_{i2}	-0.00011	-0.268675	0.00002	0.054371	0.00005	0.139653	0.00004	0.151672
γ_{i3}	0.00029	0.937135	0.00025	0.855764	-0.00053	-2.15402	-0.00001	-0.065437
δ_{i1}	0.00771	0.967141	-0.01668	-3.30727	0.01409	2.54005	-0.00512	-1.08415
δ_{i2}	-0.01668	-3.30727	0.04377	7.20308	-0.03115	-7.53141	0.00407	1.15875
δ_{i3}	0.01409	2.54005	-0.03115	-7.53141	0.02578	3.88425	-0.00872	-2.17807
δ_{i4}	-0.00512	-1.08415	0.00407	1.15875	-0.00872	-2.17807	0.00977	1.65787
β_i	-0.00079	-0.17596	-0.05528	-13.0617	0.01768	5.17827	0.03839	12.4369

Number of observations = 10200 Log likelihood = 6040.10 * Table t at 5% = 1.96
R-Sq (equation 1) = .050543 R-Sq (equation 2) = .072460 R-Sq (equation 3) = .041242

Expenditure effects (β_i) account for the changes in meat budget shares resulting from changes in total household meat expenditures within each income group. Across the four income groups and for the four meat products, the majority of the coefficients are statistically significant thus showing that a change in meat expenditures has a significant effect on the budget shares. Beef, pork and fish usually show positive values for β while poultry presents a negative β value. In the case of beef under the lower income groups, β is insignificant.

Table 5.3: AIDS estimates for meat products for income from \$50,000 to \$74,999 (scenario 1).

	Beef		Poultry		Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.26528	2.76423	0.44550	4.72544	0.08896	1.14830	0.20026	2.81058
λ_{i1}	-0.03775	-2.04175	-0.06592	-3.16105	-0.01721	-1.22861	0.12088	7.12368
λ_{i2}	0.002523	0.318923	0.004282	0.51364	0.00422	0.70088	-0.01103	-1.69956
λ_{i3}	0.012644	1.56474	0.027128	3.09472	0.00812	1.29968	-0.04789	-6.9917
λ_{i4}	0.003254	0.377832	0.002531	0.29997	-0.02344	-3.93625	0.01765	2.55521
λ_{i5}	-0.00275	-0.481280	0.006902	1.23098	-0.00038	-0.09118	-0.00377	-0.84074
λ_{i6}	-0.01821	-3.63951	0.020258	4.13328	-0.00260	-0.68020	0.00055	0.15746
λ_{i7}	0.017763	2.67411	-0.00176	-0.26523	-0.00970	-1.91007	-0.00631	-1.38939
λ_{i8}	0.020713	3.93303	-0.04694	-9.05310	0.02314	5.46251	0.00309	0.80011
λ_{i9}	-0.01101	-2.25257	0.017382	3.63143	-0.00510	-1.34804	-0.00127	-0.34854
λ_{i10}	-0.03559	-6.67235	0.032549	5.95658	-0.00014	-0.03231	0.00318	0.76318
λ_{i11}	0.009783	1.58629	-0.02318	-3.92156	0.02772	5.52114	-0.01432	-3.55642
λ_{i12}	0.003556	0.655709	-0.00121	-0.22757	-0.00257	-0.60576	0.00022	0.05636
λ_{i13}	0.030103	3.50451	-0.00898	-1.18197	-0.00294	-0.45419	-0.01819	-3.66455
λ_{i14}	-0.00404	-0.431756	-0.00763	-0.91227	0.01210	1.57944	-0.00043	-0.07732
μ_{i1}	-0.00776	-1.13666	-0.01021	-1.58417	-0.01378	-2.56828	0.03174	6.18819
μ_{i2}	0.013397	2.12379	-0.01549	-2.62410	0.00869	1.75170	-0.00660	-1.49086
μ_{i3}	0.037103	5.55130	-0.01803	-2.78578	-0.01379	-2.74862	-0.00529	-1.11933
ϵ_{i1}	0.026064	0.265228	0.109929	1.13733	0.15436	1.92782	-0.29036	-4.11676
γ_{i1}	-0.01154	-1.00233	0.007948	0.70775	-0.00849	-0.93527	0.01208	1.50773
γ_{i2}	0.000661	1.37999	-0.00017	-0.33656	-0.00026	-0.65448	-0.00023	-0.65434
γ_{i3}	0.000784	1.95234	-0.000075	-0.19175	-0.00009	-0.28116	-0.00062	-2.18376
δ_{i1}	0.090703	9.72974	-0.02295	-3.6329	-0.02937	-4.52686	-0.03838	-6.38975
δ_{i2}	-0.02295	-3.63298	0.065026	8.0597	-0.03471	-6.40431	-0.00737	-1.51866
δ_{i3}	-0.02937	-4.52686	-0.03471	-6.40431	0.08676	10.7599	-0.02269	-4.40900
δ_{i4}	-0.03838	-6.38975	-0.00737	-1.51866	-0.02269	-4.40900	0.06844	8.17183
β_i	0.018263	2.97046	-0.07206	-11.64400	0.01528	3.24073	0.03852	8.73436

Number of observations = 5865 Log likelihood = 4036.67 * Table t at 5% = 1.96
R-Sq (equation 1) = .051018 R-Sq (equation 2) = .089662 R-Sq (equation 3) = .054711

The R^2 shows that in the four equations and for the four income groups usually less than 8 percent of the variation has been explained. While a higher goodness-of-fit would be preferred, these low values are typical when using large pooled data sets (Edgerton and Assarsson, 1996). Hence, the low R^2 should not be of major concern. In Chapters 6 and 7, the results from Tables 5.1 to 5.4 will be extensively used to show the impacts of each demand factor. What is important at this juncture is that the AIDS models have been estimated giving empirical values that are reasonable both theoretically and quantitatively. These estimates then provide the basis for later economic inferences.

Table 5.4: AIDS estimates for meat products for income over $75,000 (scenario 1).

	Beef		Poultry		Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.35914	2.82377	0.61648	4.73312	0.14337	1.43494	-.11899	-1.19184
λ_{i1}	-0.02996	-1.12620	-0.02821	-0.84351	0.05415	2.01115	0.00401	0.16925
λ_{i2}	-0.01791	-1.74213	0.01112	0.89131	-0.01303	-1.30913	0.01982	2.17013
λ_{i3}	0.02914	2.47282	-0.00317	-0.23478	-0.02759	-2.62061	0.00162	0.16086
λ_{i4}	-0.00178	-0.10846	0.02824	1.53659	-0.04605	-4.44453	0.01958	1.21659
λ_{i5}	0.00105	0.11209	0.00664	0.64963	0.01159	1.84297	-0.01928	-2.22606
λ_{i6}	-0.00591	-0.87461	0.03326	4.72507	-0.02129	-3.90519	-0.00606	-1.20055
λ_{i7}	-0.01403	-1.62291	0.00523	0.57449	0.00977	1.40796	-0.00098	-0.15368
λ_{i8}	0.01541	1.88807	-0.04117	-4.78618	0.02294	3.42100	0.00281	0.48062
λ_{i9}	0.00810	1.36977	-0.00690	-1.13373	0.00042	0.08917	-0.00161	-0.37184
λ_{i10}	-0.02644	-3.88516	0.02417	3.38567	-0.01324	-2.38610	0.01550	2.77383
λ_{i11}	-0.00444	-0.50188	-0.00073	-0.07919	0.03868	5.06879	-0.0335	-6.13107
λ_{i12}	0.03191	4.56108	-0.02483	-3.57921	-0.01626	-2.96903	0.00918	1.71993
λ_{i13}	-0.05973	-5.01527	0.03557	2.88069	0.02537	2.33058	-0.00122	-0.14046
λ_{i14}	0.08382	6.05175	-0.05970	-4.69016	-0.01115	-1.04181	-0.01298	-1.31599
μ_{i1}	-0.00488	-0.52807	-0.00929	-0.971048	-0.01599	2.10252	-0.00182	-0.24943
μ_{i2}	0.01568	1.88451	-0.02801	-3.38288	0.00302	0.46338	0.00931	1.38928
μ_{i3}	0.02168	2.51286	-0.00660	-0.75859	-0.02751	-4.21139	0.01242	1.81830
ϵ_{i1}	-0.26413	-1.96949	-0.03841	-0.28119	0.01739	0.16066	0.28516	2.72062
γ_{i1}	0.00557	0.38311	-0.00175	-0.11242	0.02414	1.99658	-0.02796	-2.40841
γ_{i2}	0.00020	0.32277	-0.00009	-0.13199	0.00030	0.59908	-0.00042	-0.87827
γ_{i3}	0.00082	1.52487	-0.00029	-0.54144	-0.00094	-2.33718	0.00041	0.95918
δ_{i1}	0.14611	11.9793	-0.02617	-3.03173	-0.04148	-5.14732	-0.07846	-9.51484
δ_{i2}	-0.02617	-3.03173	0.074319	6.62869	-0.03397	-4.92552	-0.01418	-2.17024
δ_{i3}	-0.04148	-5.14732	-0.03397	-4.92552	0.11930	11.5623	-0.04386	-6.72585
δ_{i4}	-0.07846	-9.51484	-0.01418	-2.17024	-0.04386	-6.72585	0.13649	13.1047
β_i	0.03158	3.80167	-0.06534	-7.53809	0.02053	3.41594	0.013229	1.90206

Number of observations = 3291 Log likelihood = 2267.37 * Table t at 5% = 1.96
R-Sq (equation 1) = .095329 R-Sq (equation 2) = .101154 R-Sq (equation 3) = .083138

Empirical Results from Scenario 2

Similar to what happened with scenario 1, the AIDS model was estimated using maximum likelihood techniques. The resulting parameters and supporting statistics for the nine meat products are presented in Tables 5.5 through 5.8. As previously seen with scenario 1, the AIDS models were estimated for each income category. Given the high number of observations present in the data set (37,866), the number of products to enter the AIDS model (nine) and the number of estimates in the AIDS model (243), estimation could not be carried out using the total number of observations. The basis problem is one of trying to estimate many parameters using the large number of observations

Table 5.5: AIDS estimates for meat products for income under $25,000 (scenario 2).

	Roast		Steak		Other Beef		Ground Beef	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	-0.06976	-1.58688	0.07237	1.22375	0.02752	0.74813	0.32330	4.21737
λ_{i1}	0.01474	4.05898	0.01527	3.24363	-0.00647	-2.24494	-0.02937	-4.83671
λ_{i2}	0.00152	0.61026	0.00578	1.69243	0.00124	0.62979	-0.01041	-2.41903
λ_{i3}	-0.00624	-2.29112	-0.00241	-0.57587	0.00017	0.07912	0.00716	1.37585
λ_{i4}	-0.01164	-3.90111	-0.00185	-0.40412	-0.00389	-1.50241	0.03753	5.66706
λ_{i5}	-0.00095	-0.42409	0.00818	2.30837	-0.00192	-0.98064	-0.00070	-0.14720
λ_{i6}	0.00276	1.18310	-0.00368	-1.19020	0.00178	0.95261	-0.00069	-0.16757
λ_{i7}	0.00217	0.65218	0.00035	0.07581	-0.00440	-1.71765	-0.00460	-0.77010
λ_{i8}	0.00505	1.08584	0.00506	0.69168	0.00648	2.78416	0.02334	3.18133
λ_{i9}	-0.00295	-0.61254	-0.01133	-1.51991	0.00665	2.60814	0.00882	1.15686
λ_{i10}	-0.00774	-2.66128	-0.00845	-2.25811	-0.00561	-2.53730	-0.00828	-1.65284
λ_{i11}	0.00428	1.56988	-0.00753	-2.18879	-0.00540	-2.65957	0.00773	1.64614
λ_{i12}	-0.00161	-0.66459	-0.00446	-1.39572	0.00122	0.60652	0.00693	1.69133
λ_{i13}	0.00584	2.40375	-0.00016	-0.04746	-0.00444	-2.28320	0.00821	1.85565
λ_{i14}	-0.00866	-2.77178	0.00753	1.61769	-0.00353	-1.33713	-0.00186	-0.31197
μ_{i1}	0.00924	2.84515	0.00464	1.12540	0.00637	2.50332	-0.00455	-0.80396
μ_{i2}	-0.00222	-0.76380	0.00212	0.56022	0.00076	0.30753	0.00680	1.34705
μ_{i3}	-0.00095	-0.31105	0.01333	3.24854	-0.00357	-1.55936	0.01701	3.20931
ϵ_{i1}	0.00738	0.15909	-0.14292	-2.38187	-0.04803	-1.26785	0.00783	0.09580
γ_{i1}	0.00817	1.60439	0.00650	0.95463	0.00633	1.44944	-0.00901	-0.97034
γ_{i2}	0.00046	2.03588	0.00042	1.40377	0.00024	1.30650	-0.00047	-1.23991
γ_{i3}	0.00035	1.86767	0.00022	0.90383	0.00017	1.12479	0.00019	0.57488
δ_{i1}	-0.03498	-3.57911	-0.00225	-0.47481	0.00193	0.42413	0.02149	4.03779
δ_{i2}	-0.00225	-0.47481	-0.02563	-2.83738	-0.01526	-4.09990	0.00457	0.80133
δ_{i3}	0.00193	0.42413	-0.01526	-4.09990	0.02042	2.43080	0.01222	2.91945
δ_{i4}	0.02149	4.03779	0.00457	0.80133	0.01222	2.91945	-0.03126	-3.00577
β_i	0.01263	6.42179	0.02706	9.91943	-0.00187	-0.83899	-0.04091	-9.81034

	Chicken		Turkey		Other Poultry	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.54414	6.81240	0.07391	1.29794	0.00875	0.65449
λ_{i1}	-0.01906	-2.94315	0.00704	1.49914	-0.00115	-1.07253
λ_{i3}	-0.01696	-3.95464	0.00422	1.37279	0.00048	0.86810
λ_{i3}	0.01058	1.96668	-0.00351	-0.99684	-0.00036	-0.62678
λ_{i4}	0.00902	1.44956	-0.00969	-2.43985	-0.00018	-0.27215
λ_{i5}	0.00290	0.63116	0.00700	2.27780	-0.00018	-0.41412
λ_{i6}	0.01280	3.02307	-0.00115	-0.39133	-0.00032	-0.44974
λ_{i7}	-0.00243	-0.39469	0.01160	2.60045	0.00081	0.61242
λ_{i8}	-0.04844	-4.99414	-0.01390	-1.99512	-0.00174	-1.24452
λ_{i9}	-0.00493	-0.49406	0.00974	1.35616	-0.00047	-0.31442
λ_{i10}	0.02282	4.40438	-0.00202	-0.55207	-0.00094	-1.81041
λ_{i11}	-0.01576	-3.35459	0.00294	0.88085	0.00094	1.30571
λ_{i12}	0.01665	3.89857	-0.00666	-2.21411	-0.00028	-0.58784
λ_{i13}	-0.00156	-0.34521	0.00141	0.44399	0.00047	0.86846
λ_{i14}	-0.00672	-1.12442	-0.00188	-0.44489	-0.00049	-1.00751
μ_{i1}	0.01684	2.97163	-0.02884	-7.87875	-0.00035	-0.35766
μ_{i2}	0.01086	2.06371	-0.02155	-6.82398	0.00019	0.25740
μ_{i3}	-0.00161	-0.30075	-0.02569	-7.75545	-0.00014	-0.18823
ϵ_{i1}	-0.26907	-3.26070	0.18930	3.05994	-0.00543	-0.25413
γ_{i1}	0.00639	0.67503	-0.01334	-1.91365	-0.00083	-0.48543
γ_{i2}	-0.00002	-0.05696	-0.00056	-1.74866	-0.00003	-0.61264
γ_{i3}	-0.00024	-0.72661	-0.00030	-1.55924	0.00003	0.72628
δ_{i1}	-0.00295	-1.03192	-0.00367	-0.92053	0.00400	1.94574
δ_{i2}	-0.00364	-0.99555	-0.00281	-0.67314	-0.00012	-0.11971
δ_{i3}	0.00106	0.48768	-0.00566	-1.69062	-0.00104	-0.60973
δ_{i4}	-0.00701	-1.53660	-0.00559	-1.11856	0.00161	1.12704
β_i	-0.04165	-9.79899	-0.00991	-3.96645	-0.00068	-0.88575

Table 5.5: Continued.

	Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	-0.06079	-0.75600	0.08054	1.30648
λ_{i1}	-0.00151	-0.23426	0.02050	4.28659
λ_{i2}	0.01208	2.69597	0.00205	0.63129
λ_{i3}	0.00728	1.38044	-0.01267	-3.19850
λ_{i4}	-0.02376	-4.31758	0.00446	0.94016
λ_{i5}	-0.00898	-2.05712	-0.00536	-1.58540
λ_{i6}	-0.00710	-1.66757	-0.00441	-1.37489
λ_{i7}	-0.00689	-1.14108	0.00339	0.69800
λ_{i8}	0.02986	3.35171	-0.00572	-0.97076
λ_{i9}	-0.00741	-0.81146	0.00189	0.29953
λ_{i10}	-0.00903	-1.73238	0.01924	4.32426
λ_{i11}	0.03156	6.45734	-0.01875	-5.52666
λ_{i12}	-0.00326	-0.78431	-0.00854	-2.65859
λ_{i13}	0.00611	1.30055	-0.01589	-5.05165
λ_{i14}	0.01228	1.92830	0.00334	0.72957
μ_{i1}	-0.01580	-2.71916	0.01244	2.85551
μ_{i2}	0.00305	0.58306	-0.00002	-0.00582
μ_{i3}	-0.00335	-0.62215	0.00499	1.20624
ϵ_{i1}	0.31306	3.71267	-0.05210	-0.83817
γ_{i1}	-0.00098	-0.10125	-0.00322	-0.46161
γ_{i2}	0.00007	0.16100	-0.00011	-0.37676
γ_{i3}	-0.00039	-1.17405	-0.00004	-0.15068
δ_{i1}	0.00752	1.65825	0.00892	2.37996
δ_{i2}	0.03509	6.61675	0.01005	2.36325
δ_{i3}	-0.00157	-0.41066	-0.01212	-3.71854
δ_{i4}	-0.00070	-0.11065	0.00467	0.91721
β_i	0.02668	6.88108	0.02863	10.13708

Number of observations = 7000
R-Sq (equation 1) = .030078
R-Sq (equation 4) = .059756
R-Sq (equation 7) = .00452346

Log likelihood = 37824.9
R-Sq (equation 2) = .037805
R-Sq (equation 5) = .057630
R-Sq (equation 8) = .056192

* Table t at 5% = 1.96
R-Sq (equation 3) = .014788
R-Sq (equation 6) = .087290

for each income group. The most immediate solution would be to reduce the number of observations for estimating the models. However there must be a clear criteria for reducing the sample size. One possible way is to randomly assign numbers to the observations; sort the data by the random numbers; then select the first say 2000 observations or whatever the appropriate limit is necessary to estimate the models.

Specifically, for each income group, the maximum number of observations was determined. For income level under \$25,000 the number was 11846; for the second income level ranging from \$25,000 to \$49,999 it was 11419; for the income group ranging from \$50,000 to \$74,999 the number

Table 5.6: AIDS estimates for meat products for income from $25,000 to $49,999 (scenario 2).

	Roast		Steak		Other Beef		Ground Beef	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.01927	0.47884	0.02188	0.38430	0.03699	1.17177	0.33540	4.52822
λ_{i1}	-0.00894	-2.04587	0.01539	2.26736	-0.00202	-0.51112	-0.07148	-8.65021
λ_{i2}	0.00599	2.34786	0.00382	0.98463	0.00038	0.17293	-0.00997	-2.14591
λ_{i3}	0.00085	0.31705	0.00298	0.71089	-0.00114	-0.48855	0.02797	5.48525
λ_{i4}	-0.01488	-5.53860	0.00729	1.71837	-0.00170	-0.73129	0.02365	4.15418
λ_{i5}	-0.00112	-0.54001	0.00432	1.38032	0.00076	0.42962	-0.00218	-0.51884
λ_{i6}	0.00269	1.30860	-0.01522	-5.06900	-0.00422	-2.62338	0.01409	3.97644
λ_{i7}	0.00108	0.43039	0.01268	3.32424	0.00087	0.40877	-0.02062	-4.53635
λ_{i8}	0.00185	0 80669	0.02075	5.35593	0.00452	2.32154	0.01211	2.86054
λ_{i9}	0.00726	3.15224	-0.00976	-2.66651	-0.00059	-0.31862	0.01210	2.92155
λ_{i10}	-0.00588	-2.47329	-0.01194	-3.62229	0.00643	3.09608	-0.02071	-5.05854
λ_{i11}	0.00006	0.02249	-0.00334	-0.94057	-0.01040	-5.10283	0.01360	2.78645
λ_{i12}	-0.00157	-0.74205	0.00844	2.61910	-0.00239	-1.38430	0.00563	1.41630
λ_{i13}	0.00683	2.68585	0.00592	1.45138	-0.00056	-0.28144	0.00783	1.58830
λ_{i14}	-0.00333	-1.08160	0.00665	1.24668	-0.00405	-1.59623	0.00275	0.45312
μ_{i1}	0.00334	1.19465	-0.00566	-1.43986	0.00070	0.29534	-0.00536	-1.03509
μ_{i2}	-0.00447	-1.76413	0.00877	2.30145	-0.00006	-0.03035	0.01374	2.82480
μ_{i3}	-0.00105	-0.37718	0.02271	5.51987	0.00125	0.53546	0.00320	0.64196
ϵ_{i1}	-0.02979	-0 73548	-0 02966	-0 48543	-0.03857	-1.13461	0.00385	0.04977
γ_{i1}	0.00076	0.15785	-0.00435	-0.64910	0.00235	0.61774	-0.00408	-0.47384
γ_{i2}	0.00040	1.73199	0.00000	0 00066	-0.00023	-1.36288	-0.00015	-0.39461
γ_{i3}	0.00005	0.28082	0.00015	0.62269	0.00021	1.56692	-0.00006	-0.20931
δ_{i1}	0.02945	3.31306	-0.02109	-4.81567	-0.02123	-5.41783	-0.00462	-0.91215
δ_{i2}	-0.02109	-4.81567	0.01965	2.47581	-0.01477	-4.59917	0.00712	1.28565
δ_{i3}	-0.02123	-5.41783	-0.01477	-4.59917	0.06777	9.85450	-0.00322	-0.79009
δ_{i4}	-0.00462	-0.91215	0.00712	1.28565	-0.00322	-0.79009	-0.00457	-0.44789
β_i	0.01109	6.33891	0.03613	12.69070	0.00120	0.68096	-0.05183	-11.55867

	Chicken		Turkey		Other Poultry	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.35294	4.57329	0.10239	1.81396	0.00963	0.89474
λ_{i1}	0.01003	0.99589	0.01111	1 46913	0.00152	1.34417
λ_{i2}	-0.01153	-2.25248	0.00442	1.22101	-0.00022	-0.43371
λ_{i3}	-0.00501	-0.91947	-0.01481	-4.03208	-0.00003	-0.04777
λ_{i4}	0.02309	3.84237	-0.01672	-4.71051	0.00002	0.03234
λ_{i5}	-0.00247	-0.57391	0.00535	2.02682	0.00043	0.82368
λ_{i6}	0.00935	2.53042	0.01135	4.12588	0.00054	0.88282
λ_{i7}	0.00464	0.97030	-0.00010	-0.03155	-0.00056	-1.15543
λ_{i8}	-0.03953	-7.33024	-0.01522	-4.07273	-0.00121	-1.61435
λ_{i9}	-0 00494	-0.91715	0.00900	2.58352	-0.00096	-1.24645
λ_{i10}	0.02753	5.87683	0.00066	0.20533	-0.00037	-0.84644
λ_{i11}	-0.02165	-4.59175	-0.00259	-0.80341	-0.00047	-0.85120
λ_{i12}	-0.00199	-0.48365	-0.00606	-2.16491	0.00016	0.31050
λ_{i13}	-0.01178	-2.44706	-0.00410	-1.31184	-0.00125	-1.88680
λ_{i14}	-0.00585	-0.99325	-0.00014	-0.03327	0.00046	0.42183
μ_{i1}	0.00890	1.70996	-0.02518	-7.43098	-0.00034	-0.60934
μ_{i2}	0.01024	2.04088	-0.02045	-6.65707	0.00094	1.28970
μ_{i3}	0.02031	3.92842	-0.02812	-8 69166	-0.00084	-1.45325
ϵ_{i1}	-0.02498	-0.31985	0.10885	1.93152	-0.00346	-0.23104
γ_{i1}	-0.00656	-0.73370	0.00078	0.12118	0.00043	0.33625
γ_{i2}	0.00013	0 34476	-0.00020	-0.63829	-0.00000	-0.02155
γ_{i3}	0.00061	1 95509	-0.00030	-1.56296	-0.00002	-0.72892
δ_{i1}	-0.00365	-1.39349	0.00439	1.29063	0.00233	1.50631
δ_{i2}	-0.00053	-0.14955	-0.00298	-0.76839	0.00086	1.01356
δ_{i3}	-0.00595	-2.76669	-0.00914	-3.27679	-0.00465	-2.87016
δ_{i4}	-0.01374	-2.97490	0.00336	0.72291	0.00235	1.95946
β_i	-0.03539	-8.16040	-0.01862	-6.23051	-0.00004	-0.07004

Table 5.6: Continued

	Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.10707	1.34961	0.01441	0.21693
λ_{i1}	0.01440	1.42363	0.02999	3.58156
λ_{i2}	0.00762	1.44533	-0.00052	-0.11778
λ_{i3}	-0.00244	-0.43431	-0.00837	-1.81833
λ_{i4}	-0.02491	-4.75276	0.00415	0.87439
λ_{i5}	0.00140	0.34764	-0.00649	-1.93333
λ_{i6}	-0.01332	-3.52220	-0.00526	-1.71241
λ_{i7}	0.00463	0.94879	-0.00262	-0.69557
λ_{i8}	0.02585	5.22860	-0.00912	-1.94923
λ_{i9}	0.00012	0.02613	-0.01224	-2.64904
λ_{i10}	-0.00823	-1.78979	0.01250	2.98534
λ_{i11}	0.03137	6.33515	-0.00658	-1.79357
λ_{i12}	-0.00384	-0.92221	0.00164	0.48611
λ_{i13}	0.01129	2.20160	-0.01418	-3.83947
λ_{i14}	-0.00154	-0.24451	0.00505	0.99759
μ_{i1}	0.00051	0.09371	0.02309	5.06479
μ_{i2}	-0.00677	-1.39042	-0.00193	-0.46828
μ_{i3}	-0.01064	-2.09944	-0.00684	-1.62493
ϵ_{i1}	0.04836	0.60742	-0.03461	-0.54060
γ_{i1}	0.00782	0.85269	0.00285	0.39347
γ_{i2}	-0.00001	-0.03222	0.00006	0.18645
γ_{i3}	-0.00037	-1.20085	-0.00027	-0.99351
δ_{i1}	0.01186	2.92425	0.00256	0.74271
δ_{i2}	0.01274	2.51248	-0.00100	-0.23472
δ_{i3}	-0.00184	-0.58364	-0.00697	-2.27857
δ_{i4}	0.01047	1.73739	0.00286	0.53340
β_i	0.01852	4.31345	0.03895	10.73218

Number of observations = 7000
R-Sq (equation 1) = .031034
R-Sq (equation 4) = .080677
R-Sq (equation 7) = .00600825

Log likelihood = 41159 5
R-Sq (equation 2) = .052562
R-Sq (equation 5) = .080199
R-Sq (equation 8) = .036611

* Table t at 5% = 1.96
R-Sq (equation 3) = .038244
R-Sq (equation 6) = .097071

of observations was 6614; and for the income group above $75,000 the number of observations was 3753. Obviously as the sample size is reduced, it could have some impact on the data distribution and, specifically, the market shares. At some point as the sample is reduced, the shares may show dramatic changes. Whereas, beyond a larger sample size there may be very little change in the share distribution. The point where the share distribution generally stabilizes gives at least the minimum number of observations that need to be included.

The shares of the different nine meat products were determined for each income group using different number of observations. The idea was to analyze the effect of the number of observations

Table 5.7: AIDS estimates for meat products for income from $50,000 to $74,999 (scenario 2).

	Roast		Steak		Other Beef		Ground Beef	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.07048	1.64257	-0.08809	-1.43284	0.03357	0.87817	0.25784	3.77044
λ_{i1}	-0.01962	-3.55132	0.01597	1.68074	0.00320	0.43175	-0.03010	-2.18092
λ_{i2}	0.01222	4.18479	0.00064	0.13993	-0.00048	-0.15411	-0.00892	-1.56889
λ_{i3}	0.00390	1.39380	-0.00287	-0.61104	0.00044	0.12540	0.00981	1.65846
λ_{i4}	-0.01598	-4.79171	0.01124	1.96548	-0.00511	-1.85165	0.01412	2.20813
λ_{i5}	0.00055	0.25485	-0.00634	-1.65716	0.00137	0.67181	0.00239	0.57191
λ_{i6}	-0.00389	-1.67873	-0.01196	-3.42190	-0.00530	-2.65900	0.00366	1.03380
λ_{i7}	0.00869	2.78900	0.00965	2.01070	0.00145	0.53139	-0.00130	-0.27561
λ_{i8}	0.00021	0.08548	0.01750	4.96248	0.00027	0.13346	0.00330	0.88589
λ_{i9}	-0.00157	-0.69959	-0.00484	-1.51779	0.00093	0.47688	-0.00422	-1.24097
λ_{i10}	-0.00931	-4.37449	-0.01814	-5.29753	0.00217	1.00037	-0.00962	-2.53718
λ_{i11}	-0.00046	-0.16595	0.00062	0.15937	-0.00795	-3.29787	0.01628	3.48245
λ_{i12}	0.00159	0.66725	0.01217	3.36303	-0.00722	-3.42522	-0.00349	-0.90015
λ_{i13}	0.00506	1.31244	-0.00305	-0.58027	-0.01121	-5.11193	0.03521	5.16677
λ_{i14}	-0.00448	-0.98809	0.00841	1.28757	0.00161	0.54532	-0.00723	-1.07199
μ_{i1}	0.01124	3.44776	-0.00909	-2.08627	-0.00322	-1.17576	-0.00611	-1.26227
μ_{i2}	-0.00303	-1.14590	0.01353	3.27640	-0.00172	-0.67624	0.00611	1.29623
μ_{i3}	-0.00192	-0.64639	0.02441	5.40944	0.00394	1.39311	0.01376	2.83109
ϵ_{i1}	-0.04724	-1 06880	-0.00391	-0.06101	-0.01376	-0.34230	0.02926	0.40832
γ_{i1}	-0.00401	-0.77372	0.00095	0.13063	-0.01245	-2.65219	0.00254	0.31086
γ_{i2}	-0.00010	-0.47784	0.00025	0.79714	-0.00024	-1.26453	0.00058	1.69614
γ_{i3}	0.00035	2.02818	0.00036	1.41148	0.00045	2.67005	-0.00001	-0.04084
δ_{i1}	0.10356	12.37090	-0.03065	-7.61824	-0.02286	-5.71092	-0.01717	-3.43597
δ_{i2}	-0.03065	-7.61824	0.11125	14.07022	-0.02283	-6.33210	-0.02753	-5.22360
δ_{i3}	-0.02286	-5.71092	-0.02283	-6.33210	0.11911	16.61104	-0.02263	-5.23845
δ_{i4}	-0.01717	-3.43597	-0.02753	-5.22360	-0.02263	-5.23845	0.10014	9.72451
β_i	0.00451	1.96733	0.04311	12.82275	0.00647	2.43237	-0.03670	-7.69310

	Chicken		Turkey		Other Poultry	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.30542	3.86216	0.18552	2.98523	0.00765	0.43311
λ_{i1}	-0.04146	-2.27818	-0.03321	-2.76570	0.00201	0.87023
λ_{i2}	-0.00365	-0.50648	0.01015	2.07764	-0.00117	-1.29589
λ_{i3}	0.02566	3.36170	0.00471	0.93122	0.00002	0.01827
λ_{i4}	0.02314	3.05248	-0.02129	-4.53858	-0.00136	-2.25132
λ_{i5}	0.00575	1.15234	0.00022	0.06988	0.00047	0.96403
λ_{i6}	0.01670	3.95082	0.00237	0.80799	-0.00030	-0.41575
λ_{i7}	-0.00036	-0.06410	-0.00008	-0.02079	-0.00054	-0.50796
λ_{i8}	-0.03055	-6.77659	-0.01815	-6.04026	-0.00047	-0.89561
λ_{i9}	-0.00196	-0.47601	0.01793	6.17022	0.00099	1.89849
λ_{i10}	0.03065	6.54206	0.00201	0.61474	0.00116	1.78460
λ_{i11}	-0.02396	-4 84386	0.00282	0.78905	-0.00095	-1.49596
λ_{i12}	0.00433	0.94579	-0.00524	-1.63022	-0.00100	-1.73529
λ_{i13}	-0.00797	-1.19064	0.00441	0.99327	-0.00182	-2.00728
λ_{i14}	0.00018	0.02497	-0.01308	-2.88793	0.00195	1.25281
μ_{i1}	0.01311	2.37836	-0.02363	-6.02545	-0.00055	-0.86144
μ_{i2}	0.01142	2.20386	-0.02723	-8.28412	-0.00113	-1.77278
μ_{i3}	0.00652	1.15346	-0.02838	-7.28782	-0.00047	-0.56315
ϵ_{i1}	-0.02615	-0 32439	0.13540	2.10321	0.01875	0.93104
γ_{i1}	0.02632	2.82604	-0.01473	-2.03393	-0.00118	-0.97691
γ_{i2}	0.00090	2.17003	-0.00091	-2.88514	-0.00010	-1.33445
γ_{i3}	-0.00011	-0.33621	-0.00012	-0.51026	-0.00004	-1.10550
δ_{i1}	-0.00551	-1.85779	-0.00817	-2.38259	-0.00201	-0.78663
δ_{i2}	-0.01387	-3.44578	-0.00458	-1.22728	0.00010	0.08337
δ_{i3}	-0.00277	-1.09521	-0.01001	-3.37323	-0.00546	-2.89788
δ_{i4}	-0.00769	-1.67789	-0.00355	-0.74771	-0.00061	-0.39026
β_i	-0.04492	-8.10762	-0.03016	-8.14709	0.00026	0.42111

Table 5.7: Continued.

	Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.04757	0.60875	0.18004	2.51031
λ_{i1}	-0.01582	-1.13095	0.11903	7.02494
λ_{i2}	0.00354	0.58623	-0.01233	-1.90537
λ_{i3}	0.00607	0.97002	-0.04773	-6.99323
λ_{i4}	-0.02279	-3.84268	0.01803	2.61626
λ_{i5}	-0.00056	-0.13461	-0.00385	-0.86175
λ_{i6}	-0.00258	-0.67186	0.00131	0.37183
λ_{i7}	-0.01101	-2.16253	-0.00649	-1.42079
λ_{i8}	0.02413	5.62034	0.00376	0.96989
λ_{i9}	-0.00573	-1.48647	-0.00153	-0.41789
λ_{i10}	-0.00090	-0.20634	0.00196	0.47081
λ_{i11}	0.02812	5.57351	-0.01453	-3.63641
λ_{i12}	-0.00220	-0.51648	0.00105	0.26523
λ_{i13}	-0.00238	-0.36653	-0.01824	-3.70842
λ_{i14}	0.01174	1.52411	0.00090	0.15999
μ_{i1}	-0.01417	-2.60795	0.03241	6.31925
μ_{i2}	0.00889	1.77511	-0.00684	-1.54653
μ_{i3}	-0.01284	-2.53753	-0.00502	-1.05598
ϵ_{i1}	0.18155	2.25002	-0.27389	-3.85470
γ_{i1}	-0.00874	-0.95909	0.01129	1.42131
γ_{i2}	-0.00018	-0.43828	-0.00020	-0.57611
γ_{i3}	-0.00024	-0.78193	-0.00064	-2.23806
δ_{i1}	-0.00660	-1.56002	-0.01058	-2.88320
δ_{i2}	0.00445	0.89099	-0.01634	-3.45874
δ_{i3}	-0.01598	-4.22551	-0.01657	-4.82188
δ_{i4}	-0.01096	-1.92601	-0.01001	--1.84644
β_i	0.01927	4.04372	0.03816	8.75201

Number of observations = 5920
R-Sq (equation 1) = .061230
R-Sq (equation 4) = .069645
R-Sq (equation 7) = .00956088

Log likelihood = 35009.0
R-Sq (equation 2) = .102554
R-Sq (equation 5) = .104302
R-Sq (equation 8) = .057478

* Table t at 5% = 1.96
R-Sq (equation 3) = .094895
R-Sq (equation 6) = .100549

used on the shares of the meat products. These results are presented in Figure 5.1 for income level under $25,000. In this figure, the meat shares are shown across different sample sizes and generally there is little variation among the meat share as the number of observations is reduced. Similar results were obtained for the other three income groups. Shares remain relatively stable across the different number of observations for the nine meat products thus indicating that some reduction in the sample size is acceptable.

A comparison of the different AIDS estimates was performed using different number of observations in the model estimation. The AIDS model was run for the four income groups using

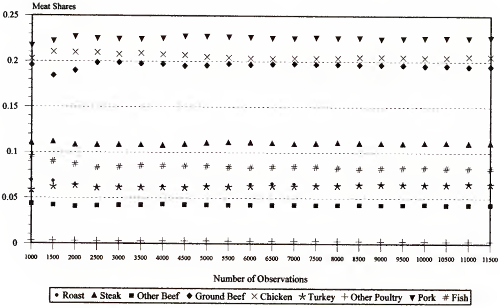

Figure 5.1: Distribution of the shares of different meat products along the number of observations (income under $25,000).

4000, 5000, 6000 and 7000 observations. The different estimates were compared and little numerical difference could be seen among the estimates obtained using a different number of observations. Based on these results, the number of observations used in the estimation of the parameters of the AIDS model could be limited. A reasonable number to be used in the AIDS model estimation across the four income groups was around 7,000 observations. With this number of observations, estimation could be carried out without any convergence problems. The results presented in this section are based on the maximum number of 7,000 observations used in the AIDS model estimation for the four income categories. Convergence was achieved after 4 iterations in each of the AIDS models. A total of 243 estimates were obtained within each income group and for the nine products. From Tables 5.5 through 5.8, the majority of the coefficients are statistically significant. Looking for instance at the lower level of income (Table 5.5), the effect of household sizes with 1 member is statistically

Table 5.8: AIDS estimates for meat products for income over $75,000 (scenario 2).

	Roast		**Steak**		**Other Beef**		**Ground Beef**	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.00941	0.16408	0.00362	0.04426	0.03488	0.70463	0.36360	4.21499
λ_{i1}	-0.03084	-3.83663	-0.02323	-2.09744	0.00838	0.54887	0.01429	0.66552
λ_{i2}	0.01150	3.10800	0.00692	1.34863	-0.00448	-0.82070	-0.02774	-3.56183
λ_{i3}	0.00588	1.48482	0.01472	2.36692	-0.00092	-0.15544	0.00980	1.08148
λ_{i4}	-0.00209	-0.29303	-0.01693	-2.49408	0.00352	0.61971	0.01315	1.05719
λ_{i5}	-0.00129	-0.31000	0.00203	0.44846	-0.00004	-0.01054	0.00175	0.25333
λ_{i6}	0.00439	1.37877	-0.00861	-1.93105	-0.00013	-0.04372	-0.00102	-0.23494
λ_{i7}	-0.00199	-0.45943	-0.00726	-1.15453	0.00389	1.01918	-0.00919	-1.63978
λ_{i8}	-0.01039	-2.84472	0.02479	4.34875	-0.00298	-1.01661	0.00440	0.82441
λ_{i9}	0.00066	0.23991	-0.00298	-0.74841	0.00151	0.66821	0.00705	1.85056
λ_{i10}	-0.00461	-1.50665	-0.01285	-2.83785	0.00566	2.02721	-0.01474	-3.28397
λ_{i11}	-0.00052	-0.13223	-0.00222	-0.38693	-0.01054	-3.22271	0.00706	1.22950
λ_{i12}	0.00413	1.19494	0.00856	1.77882	0.00021	0.07228	0.01836	3.92447
λ_{i13}	0.00313	0.55432	-0.01586	-2.04539	-0.00446	-0.86278	-0.03916	-5.18351
λ_{i14}	-0.00420	-0.65908	0.02225	2.27929	0.00412	0.75354	0.05565	5.56501
μ_{i1}	0.00736	1.78950	-0.00471	-0.76561	-0.00480	-1.25009	-0.00258	-0.45418
μ_{i2}	-0.00153	-0.42910	0.01034	1.89758	0.00005	0.01433	0.00814	1.47007
μ_{i3}	-0.00181	-0.45825	0.02273	3.93245	0.00008	0.02296	0.00808	1.40114
ϵ_{i1}	-0.01306	-0.22019	-0.13769	-1.60507	0.00327	0.05768	-0.24841	-2.77207
γ_{i1}	0.00374	0.54172	-0.00374	-0.41082	-0.01202	-2.04801	0.01468	1.60904
γ_{i2}	-0.00019	-0.66329	0.00020	0.47422	-0.00017	-0.65234	0.00037	0.87915
γ_{i3}	0.00045	1.82997	0.00027	0.75091	0.00059	2.44961	-0.00019	-0.54345
δ_{i1}	0.12932	11.51919	-0.02707	-4.86814	-0.03331	-7.55457	-0.01937	-3.41625
δ_{i2}	-0.02707	-4.86814	0.12704	12.31342	-0.01760	-4.22954	-0.02186	-3.44384
δ_{i3}	-0.03331	-7.55457	-0.01760	-4.22954	0.13445	14.70558	-0.01413	-2.92409
δ_{i4}	-0.01937	-3.41625	-0.02186	-3.44384	-0.01413	-2.92409	0.13823	12.95433
β_i	0.00654	1.79187	0.04127	7.71753	0.00313	1.02839	-0.01886	-3.09491

	Chicken		**Turkey**		**Other Poultry**	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.39380	3.68037	0.25423	3.05639	-0.00633	-0.26743
λ_{i1}	-0.04803	-1.83590	0.01345	0.58724	0.00452	0.70128
λ_{i2}	0.01162	1.16999	-0.00143	-0.17226	-0.00013	-0.05260
λ_{i3}	0.00494	0.45958	-0.00738	-0.83539	-0.00061	-0.23549
λ_{i4}	0.01589	1.12624	0.00993	0.80941	-0.00123	-0.63749
λ_{i5}	0.01157	1.45220	-0.00144	-0.21618	-0.00075	-0.65364
λ_{i6}	0.01885	3.14891	0.01936	4.49109	-0.00324	-2.30448
λ_{i7}	0.00611	0.78840	-0.00483	-0.97194	0.00344	1.35725
λ_{i8}	-0.02167	-3.04917	-0.02036	-3.87081	-0.00057	-0.43211
λ_{i9}	0.00221	0.42491	-0.00706	-1.98317	-0.00046	-0.47921
λ_{i10}	0.01641	2.68986	0.00875	1.96067	0.00136	0.95415
λ_{i11}	-0.00712	-0.89631	0.00473	0.82671	-0.00105	-0.72519
λ_{i12}	-0.00882	-1.49248	-0.01256	-3.03832	-0.00122	-1.47790
λ_{i13}	0.02088	1.89309	0.01606	2.05706	-0.00266	-1.33116
λ_{i14}	-0.03651	-3.17200	-0.02331	-3.60252	0.00134	0.40519
μ_{i1}	0.01181	1.44853	-0.02511	-4.81119	0.00250	1.16331
μ_{i2}	0.00749	1.01685	-0.03374	-7.79364	-0.00029	-0.21455
μ_{i3}	0.03122	4.00470	-0.04250	-9.42318	-0.00292	-2.02925
ϵ_{i1}	-0.01117	-0.09893	-0.01578	-0.18380	0.03533	1.25503
γ_{i1}	-0.00610	-0.47526	0.00690	0.67509	0.00226	1.03755
γ_{i2}	-0.00001	-0.02500	-0.00000	-0.00947	0.00001	0.06931
γ_{i3}	0.00039	0.81705	-0.00071	-2.66157	-0.00011	-0.86983
δ_{i1}	-0.02279	-5.44006	-0.00541	-1.20907	-0.00540	-1.85056
δ_{i2}	-0.00702	-1.19709	-0.01328	-2.82924	0.00090	0.50472
δ_{i3}	-0.00798	-2.12173	-0.00959	-2.56275	-0.00782	-3.26356
δ_{i4}	-0.00633	-1.12470	-0.01893	-3.66918	0.00060	0.29160
β_i	-0.04507	-5.78112	-0.02365	-4.59359	0.00036	0.37064

Table 5.8: Continued.

	Pork		Fish	
	Coefficient Estimates	Coefficients t-values*	Coefficient Estimates	Coefficients t-values*
α_i	0.09744	0.97030	-0.15063	-1.50280
λ_{i1}	0.05298	1.96481	0.00851	0.35440
λ_{i2}	-0.01306	-1.30677	0.01681	1.83024
λ_{i3}	-0.02721	-2.58408	0.00079	0.07774
λ_{i4}	-0.04403	-4.30332	0.02179	1.33386
λ_{i5}	0.00961	1.54019	-0.02144	-2.45364
λ_{i6}	-0.02179	-3.93854	-0.00781	-1.53324
λ_{i7}	0.00951	1.35295	0.00031	0.04855
λ_{i8}	0.02261	3.32505	0.00419	0.71308
λ_{i9}	0.00051	0.10756	-0.00143	-0.32950
λ_{i10}	-0.01326	-2.37577	0.01328	2.38552
λ_{i11}	0.04187	5.37336	-0.03222	-5.87703
λ_{i12}	-0.01873	-3.40133	0.01007	1.88227
λ_{i13}	0.02805	2.55026	-0.00598	-0.67739
λ_{i14}	-0.01419	-1.32466	-0.00516	-0.49552
μ_{i1}	0.01526	1.99702	0.00028	0.03797
μ_{i2}	0.00155	0.23603	0.00800	1.20292
μ_{i3}	-0.02686	-4.08335	0.01198	1.73256
ϵ_{i1}	0.05914	0.54571	0.32837	3.14348
γ_{i1}	0.02165	1.78226	-0.02736	-2.36741
γ_{i2}	0.00034	0.67414	-0.00054	-1.12685
γ_{i3}	-0.00097	-2.40095	0.00029	0.67687
δ_{i1}	0.00214	0.39874	-0.01811	-3.96675
δ_{i2}	-0.00421	-0.67269	-0.03688	-5.98415
δ_{i3}	-0.01298	-2.55320	-0.03104	-7.73540
δ_{i4}	-0.02384	-3.55612	-0.03437	-5.70062
β_i	0.02012	3.30302	0.01616	2.29828

Number of observations = 3320
R-Sq (equation 1) = .088649
R-Sq (equation 4) = .095334
R-Sq (equation 7) = .017526

Log likelihood = 18848.7
R-Sq (equation 2) = .124745
R-Sq (equation 5) = .124949
R-Sq (equation 8) = .083967

* Table t at 5% = 1.96
R-Sq (equation 3) = .135583
R-Sq (equation 6) = .144433

significant and different from an average household for roast, steak, other types of beef, ground beef, chicken and fish. Still in the same income level, females under 29 years old and in the age range from 30 to 49 years old are statistically significant and different from the average household in the case of turkey and pork consumption. In terms of the effect of female education on the different meat shares, there is a statistically significant effect of females with a college education on roast, steak, ground beef, turkey and fish budget shares (Table 5.6). The effect of any type of demographic on the different meat shares across the four income categories can be evaluated based on the estimates presented in Tables 5.5 through 5.8. However, in this section the focus is on the significance levels

of the estimated parameters. In Chapters 6 and 7, a more detailed analysis of the effect of the different demographics on the meat budget shares will be carried out using demand and market shares elasticities and simulations. Similar to what was shown with scenario 1, the seasonality, health, promotions and advertising effects on the different meat shares can be evaluated.

For all the income categories, significant seasonality coefficients are present with the consumption of turkey. In the income level under $25,000, the health coefficients are statistically significant for steak, chicken, turkey and pork. In general the effect of promotions and advertizing while the signs are correct the estimates are not statistically significant. This again is most likely due to the short time period considered in this study in a similar way to the results obtained from scenario 1. Price effects seem to be more significant for higher levels of income, in a similar way to what was observed with scenario 1. The majority of expenditure effects are statistically significant, indicating how meat shares change as total meat expenditures are adjusted.

Using the R-square as a quasi-measure of goodness-of-fit, this statistic shows the amount of variation explained to be under 12 percent for the different expenditure equations. Once again, these low values should not be of major concern due to the use of large pooled data sets. Across the different income groups, the number of observations ranged from 3000 to 7000, with the lower values being from the higher income groups. In some cases it was not necessary to reduce the sample size since convergence could be achieved with the full data set.

Stability of the Models

In the estimation of the different AIDS models under different scenarios, adding-up, homogeneity and symmetry demand conditions were imposed. Negativity is another demand conditions that needs to be taken into account in the AIDS model estimation. The negativity condition

is related to one of the assumptions of consumer theory. Consumer preferences are convex or in other words, the utility function exhibits a concave shape. The second order condition for utility maximization requires that the Hessian matrix of the utility function is negative semi-definite. A matrix is negative semi-definite when the principal minors of the Hessian determinant alternate in sign starting with the first principal minor being negative. Table 5.9 includes these negativity tests. Analyzing Table 5.9 for the income groups under \$25,000, between \$25,000 and \$49,999 and between \$50,000 and \$74,999 the negativity condition is satisfied The first principal minors are negative, the second is positive and the third is negative. However, the determinant of the entire Hessian matrix is not positive, but zero. In this case, the utility function exhibits weak concavity.

In Table 5.10 are presented the results from the negativity test performed to the coefficient estimates obtained from scenario 2. The principal minors do not have the expected signs hence we are less confident in the nine product results.

Table 5.9: Results from the negativity tests for the four products (scenario 1).

Negativity Test	First Principal Minor	Second Principal Minor	Third Principal Minor	Whole Matrix
Income 1 (under \$25,000)	-0.26273	0.03528	-0.00257	-0.00000
Income 2 (\$25,000 to \$49,999)	-0.23237	0.02542	-0.00140	-0.00000
Income 3 (\$50,000 to \$74,999)	-0.14832	0.01053	-0.000147	-0.00000
Income 4 (over \$75,000)	-0.09072	0.00377	0.00027	0.00000

Table 5.10: Results from the negativity tests for the nine products (scenario 2).

Negativity Test	Income 1 (under $25,000)	Income 2 ($25,000 to $49,999)	Income 3 ($50,000 to $74,999)	Income 4 (over $75,000)
First Principal Minor	-0.09374	-0.02939	0.04437	0.07021
Second Principal Minor	0.01188	0.002191	0.00010	0.00169
Third Principal Minor	-0.00025	0.00008	-0.00003	0.00010
Fourth Principal Minor	0.00003	-0.00001	-0.00000	-0.00000
Fifth Principal Minor	-0.00000	0.00000		-0.00000
Sixth Principal Minor	0.00000	-0.00000	-0.00000	-0.00000
Seventh Principal Minor	-0.00000	0.00000	-0.00000	-0.00000
Eighth Principal Minor	0.00000	-0.00000	0.00000	0.00000
Whole Matrix	0.00000	0.00000	-0.00000	0.00000

Comparison of the Different Scenarios

In Chapter 4 (Table 4.1) eight different scenarios were presented to be considered in the estimations of the AIDS model. The different scenarios differ in the number of meat products considered in the study, the consumption of all meat products during a particular time period, the number of times an individual household reports and the time of the survey. A comparison among different household consumption possibilities will be made based on the shares determined under the different scenarios. The shares are going to be presented in Chapter 7 in the simulation section.

Comparison Between Scenarios 1 and 3

The difference between these two scenarios is that in scenario 3 all meat products are being consumed by the household at the same time period, while in scenario 1 not all meat products are being consumed by the household at the same time period. All the other constraints are the same between these two scenarios (see Table 4.1 in Chapter 4).

Comparison Between Scenarios 1 and 5

The difference between these two scenarios is the number of times households report during a quarter. In scenario 1 households reported at least one time while in scenario 5 households reported at least two times. All the other constraints remain fixed between these two scenarios (see Table 4.1 in Chapter 4).

Comparison Between Scenarios 5 and 7

This comparison is similar to the one previously performed between scenarios 1 and 3. While in scenarios 1 and 3, households reported at least one time during a quarter, in the case of scenarios 5 and 7 households reported at least two times during a quarter.

Comparison Between Scenarios 3 and 7

This analysis is similar to the comparison previously done between scenarios 1 and 5. The only difference is that in this case all meat products are being consumed by the households at the same time period.

A comparison among the different scenarios proved that there was little numerical differences among them. In all the cases the difference among the shares was under seven percentage points. Based on these findings it is concluded that the number of times households report during a quarter and the consumption of the four meat products by the household at the same period have little, if any, impact on the coefficients estimates and the meat shares. A more detailed comparison of these different scenarios is going to be presented in Chapter 6 with the different elasticities. In relation to the nine products, similar comparisons were made and the results were similar. Both the number of reporting times and the consumption of the nine meat products at the same time period did not have a statistically significant effect on the results obtained.

In this chapter the coefficient estimates obtained from the AIDS model were reported for the four and nine meat products under the four income categories ranging from under $25,000 a year to over $75,000 a year. The different model coefficients were divided into demographic, seasonality, health, promotion, advertizing and price effects. Reasonable results were obtained in terms of the coefficients estimates. During the next chapters, little focus will be put into the health and promotion effects due to the limited time period that this analysis was based on (last quarter of 1992 through first quarter of 1998). Much of the health and promotion effects are extended over a longer time frame, hence making it more difficult to adequately capture the variation in these variables. Also, the health and promotion variables were measured externally to the households and imposed equally to all households within a quarter. This along with the short time period complicated meaningful estimation

of these two effects. Another study done by (Ward, 1999) using a beef servings data set ranging from 1984 through 1997 showed a positive effect on demand by promotions. In Chapter 6, a more detailed analysis of the AIDS estimates will be set forth and in Chapter 7 the impact of the different factors on the meat budget shares will be analyzed. As understanding demographic differences and their impacts on purchasing decisions is a fundamental aspect of demand analysis for an industry, concentration will be put on the impact of the different demographic variables on the budget shares.

CHAPTER 6
DEMAND AND MARKET SHARE ELASTICITIES

Chapter 5 concentrated on a general discussion of the econometric estimates obtained using the AIDS model. The model was run for either four or nine meat products under different scenarios and results were compared, taking into account the four income groups. Scenarios one and two (Chapter 4) were the ones chosen to be representative for four and nine products respectively. In this chapter, a more detailed analysis of the significance of the different parameter estimates will be presented. Different elasticities of demand, including own price, cross price, expenditure, price share and expenditure share will be useful for showing the meaning of the different econometric estimates and the allocation of the budget shares among the several meat products. In addition to the elasticities, demand curves for different meat products are shown for the four income groups. Simulations of the impact of changes in total meat expenditures on the allocation of the budget shares among the different meat products are also presented.

Demand Curve Simulations

Estimated demand responses for the four meat products (i.e., beef, poultry, pork and fish) are presented in Figures 6.1 through 6.4, thus illustrating the nature of the demand for these four products across the different income groups. Demands were determined knowing the prices and quantities consumed of the four meat products. Mean prices of the four meat products were adjusted

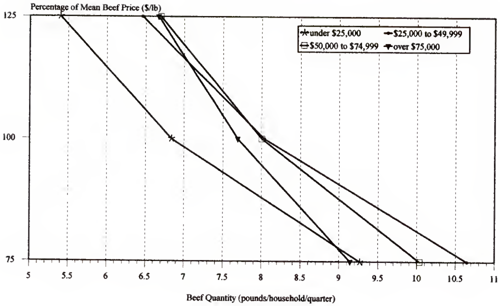

Figure 6.1: Household demand curve for beef.

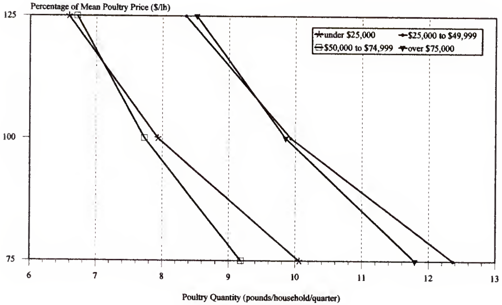

Figure 6.2: Household demand curve for poultry.

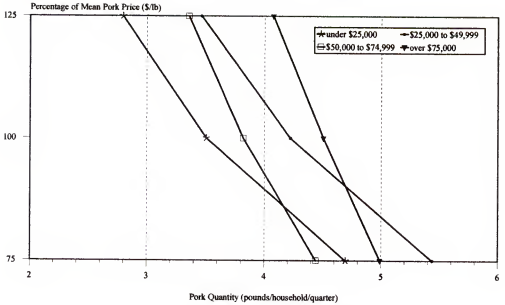

Figure 6.3: Household demand curve for pork.

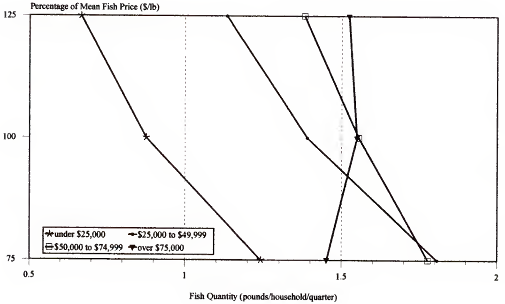

Figure 6.4: Household demand curve for fish.

from 75 percent of the mean level to 125 percent of the mean and respective quantities were calculated. Table 6.1 presents the mean prices of the different meat products across the four income groups. Quantity demanded by each meat product for each income group was computed by multiplying each simulated share amount by total meat expenditures and then dividing by the respective meat price.

$$\tilde{x}_i = \frac{\tilde{w}_i * m}{\tilde{p}_i} \tag{6.1}$$

where $\tilde{x}_i$ is the simulated quantity demanded of each meat product by income group, $\tilde{w}_i$ represents the simulated budget share by income group, m is total meat expenditures by income group, and $\tilde{p}_i$ is the simulated price of the meat product.

Table 6.1: Mean Prices for the Different Meat Products under the Four Income Levels.

	Beef	Poultry	Pork	Fish
	----------	$ per pound	----------	
under $25,000	1.911	1.244	1.930	3.489
$25,000 to $49,999	2.015	1.339	2.029	3.697
$50,000 to $74,999	2.255	1.507	2.200	3.905
over $75,000	2.414	1.551	2.231	4.288

In Figure 6.1, the demand curve for beef under each income group is downward sloping, as theoretically expected. The four demand curves are relatively inelastic as will be shown in agreement later in this chapter. The highest inelastic demand corresponds to households with income over $75,000. The mean prices of beef across the four income groups oscillated between $1.91 per pound and $2.41 per pound. The lowest price occurred for the income group under $25,000 and the highest price under the highest income group. In both income groups from $25,000 to $49,999 and from

$50,000 to $74,999, the quantity of beef demanded per household in a quarter was close to 8 pounds at the mean price level.

Household demand curves for poultry are presented in Figure 6.2. In this case the mean prices for poultry are in the range between $1.24 per pound and $1.55 per pound. At the mean price, the highest quantity of poultry demanded was 9.93 pounds for the income group from $25,000 to $49,999. Similar to what was seen with beef, demand curves are downward sloping and have different slopes. The different elasticities will be presented later in this chapter and a comparison among the different income groups will be completed.

In the case of pork (Figure 6.3), the quantities demanded by the households at the mean price in a quarter are between 3.5 and 4.5 pounds. Mean prices oscillate between $1.93 and $2.24 per pound. Among the four meats, fish presents the highest mean prices, between $3.49 and $4.29 per pound, and the lowest quantities demanded by the households (Figure 6.4). The demand curve for fish under the income level over $75,000 does not have the expected slope.

Expenditures Simulation (Scenario 1)

In Figures 6.5 through 6.8 the impact of changes in total meat expenditures on the four meats budget shares is simulated. Simulations were performed with changes in the meat expenditures in the range of 50 to 150 percent of the mean expenditures on meat for each income group. Using this range, the allocation of expenditures among the four meat products can be evaluated across the four income groups. Table 6.2 presents the mean values of expenditures on the four meat types by income groups. As shown in Figure 6.5, as expenditure levels were increased beef shares increased, except for the

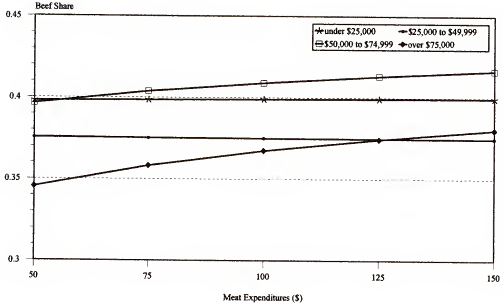

Figure 6.5: Impact of changes in meat expenditures on beef shares.

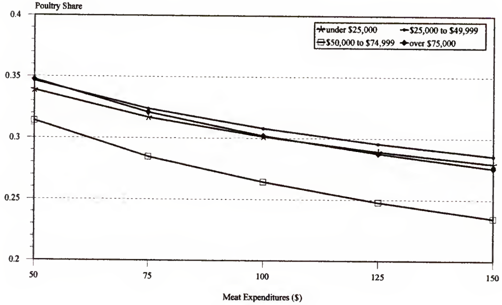

Figure 6.6: Impact of changes in meat expenditures on poultry shares.

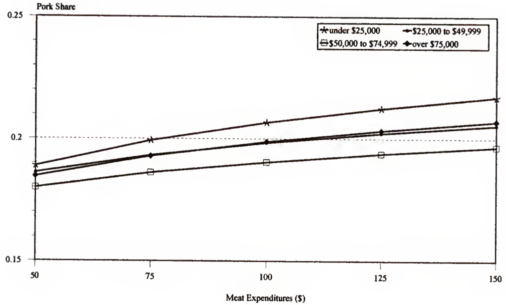

Figure 6.7: Impact of changes in meat expenditures on pork shares.

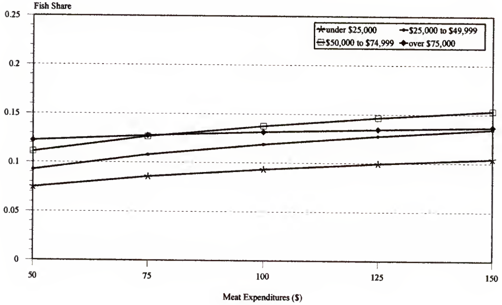

Figure 6.8: Impact of changes in meat expenditures on fish shares.

$25,000 to $49,999 income group. In the case of poultry, all the shares across the different income groups decreased with the lowest values being seen under the income group from $50,000 to $75,000. Pork and fish shares increased when meat expenditures were increased. Under the income group under $25,000, pork shares were the highest, while in the case of fish this same income group provided the lowest shares. In conclusion, the market shares gained by beef, pork and fish were at the expense of poultry for the meat part.

Table 6.2: Mean Expenditures of the Four Meat Types under Different Income Levels .

	Meat Expenditures ($)
under $25,000	32.75
$25,000 to $49,999	43.20
$50,000 to $74,999	44.13
over $75,000	50.57

Demand and Market Share Elasticities for Scenario 1

The different demand elasticities are presented in this section for the four meat types under the four income levels as previously defined in Chapter 4. Price, both uncompensated and compensated, expenditure and market share elasticities are computed under the four income levels. Differences are expected across incomes. For instance, price elasticities are expected to decrease in absolute value as income goes up. The allocation of expenditures on the different meat types should be influenced by the income categories . Share elasticities, including expenditure share and price share elasticities, measure the effect of prices and expenditures on meat shares.

Price Elasticities

Uncompensated and compensated price elasticities are presented in Table 6.3 and 6.4 for the four meat products and income groups. As defined in Chapter 2, compensated elasticities are net of income effects, thus providing a more accurate interpretation of the coefficient estimates determined in Chapter 5. All own price elasticities are negative, except for fish under the highest income level. As expected, going from the lowest to the highest income groups, elasticities are less elastic. There

Table 6.3: Uncompensated price elasticities of demand (ϵ_{ij}) for meat products under the four income groups where j impacts i.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
ϵ_{11} (beef)	-1.058	-0.9786	-0.7938	-0.6249
ϵ_{12} (beef / poultry)	-0.04566	-0.04347	-0.07817	-0.1156
ϵ_{13} (beef / pork)	0.06462	0.03789	-0.07817	-0.1243
ϵ_{14} (beef / fish)	0.03576	-0.01367	-0.09454	-0.2212
ϵ_{22} (poultry)	-0.8304	-0.7701	-0.6193	-0.6424
ϵ_{21} (poultry / beef)	0.01265	0.01358	0.008809	-0.02953
ϵ_{23} (poultry / pork)	-0.04407	-0.07594	-0.09269	-0.08399
ϵ_{24} (poultry / fish)	0.04177	0.01197	-0.02380	-0.02788
ϵ_{33} (pork)	-1.014	-0.8825	-0.5557	-0.4135
ϵ_{31} (pork / beef)	0.07635	0.03741	-0.1824	-0.2359
ϵ_{32} (pork / poultry)	-0.1560	-0.2007	-0.2219	-0.2241
ϵ_{34} (pork / fish)	-0.03073	-0.04337	-0.1203	-0.2297
ϵ_{44} (fish)	-1.220	-0.9156	-0.5065	0.02996
ϵ_{41} (fish / beef)	0.03860	-0.1650	-0.3774	-0.6238
ϵ_{42} (fish / poultry)	-0.006670	-0.1237	-0.1918	-0.1598
ϵ_{43} (fish / pork)	-0.1023	-0.1187	-0.2046	-0.3470

Table 6.4: Compensated price elasticities of demand (ϵ_{ij}) for meat products under the four income groups where j impacts i.

	Under \$25,000	\$25,000 to \$49,999	\$50,000 to \$74,999	Over \$75,000
ϵ_{11} (beef)	-0.6579	-0.6046	-0.3667	-0.2260
ϵ_{12} (beef / poultry)	0.2565	0.2638	0.1979	0.2124
ϵ_{13} (beef / pork)	0.2720	0.2358	0.1207	0.09162
ϵ_{14} (beef / fish)	0.1293	0.1049	0.04911	-0.07854
ϵ_{22} (poultry)	-0.5835	-0.5174	-0.4272	-0.4057
ϵ_{21} (poultry / beef)	0.3397	0.3211	0.3062	0.2583
ϵ_{23} (poultry / pork)	0.1254	0.08676	0.04577	0.07179
ϵ_{24} (poultry / fish)	0.1182	0.1095	0.07621	0.07508
ϵ_{33} (pork)	-0.7819	-0.6665	-0.3500	-0.1942
ϵ_{31} (pork / beef)	0.5249	0.4456	0.2592	0.1693
ϵ_{32} (pork / poultry)	0.1828	0.1347	0.06353	0.1091
ϵ_{34} (pork / fish)	0.07412	0.08610	0.02821	-0.08472
ϵ_{44} (fish)	-1.100	-0.7584	-0.3305	0.1746
ϵ_{41} (fish / beef)	0.5532	0.3309	0.1460	-0.2195
ϵ_{42} (fish / poultry)	0.3819	0.2837	0.1465	0.1726
ϵ_{43} (fish / pork)	0.1643	0.1436	0.03906	-0.1282

is a decrease in price response as income increases where low income households are more sensitive to price changes than higher income households. For instance in the case of beef own price elasticities vary between -1.06 for the lower income level and -0.62 for the highest income group. Similar to what happened with the uncompensated price elasticities, in the case of the compensated ones (Table 6.4), all own price elasticities are negative, except for fish under the highest income level. They oscillate between -.22 for beef under the highest income level and -1.1for fish under the lowest income level. Once again, there is a decrease on the price elasticities as income goes up. Cross price

elasticities also decrease with higher income levels. The degree of substitutability between the different meat products decreases going from income levels under $25,000 to income levels above $75,000. Using the cross price elasticities, there is little substitutability between fish and the other three meat products, while beef shows the highest degrees of substitutability with the other products. Within the income group under $25,000, the effect of an increase in the price of beef on the quantity of pork purchased by the household is about three times higher than the effect of an increase in the price of poultry (i.e., comparing ϵ_{31}=.525 to ϵ_{32}=.183). Also, the degree of substitutability of beef on fish (ϵ_{41}=.553) in comparison with fish on beef (ϵ_{14}=.129) is about four times higher.

Expenditure Elasticities

Expenditure elasticities measure the change in the demand for the four different meat products as the allocation of household expenditures among these meat products changes. Expenditure elasticities (Table 6.5) were calculated at the mean values according to the equation (4.26) defined in Chapter 4. In general, poultry presents the lowest expenditure elasticities, while fish presents the highest values. While each elasticity will change when moving away from the mean prices and the

Table 6.5: Expenditure elasticities for meat products under the four income groups.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
η_1 (beef)	1.003	0.9979	1.045	1.086
η_2 (poultry)	0.8201	0.8205	0.7273	0.7836
η_3 (pork)	1.125	1.089	1.080	1.103
η_4 (fish)	1.290	1.323	1.280	1.101

average household, interestingly poultry loses relative to the other meats when the total meat expenditures increase. Fish shows the largest relative gain (or loss if expenditures decline). Comparing the expenditure elasticities across income groups, there are some small differences in terms of expenditure elasticities. For pork, households in the income group under $25,000 have the highest expenditure elasticity, while in the case of fish households with an income level between $25,000 and $49,999 have the highest expenditure elasticity.

Share Elasticities

Both expenditure share and price share elasticities are considered in this section. Expenditure share elasticities measure the effect of a change in expenditures on market shares of the different meat types. Price share elasticities are responsible for the effect of price changes on market shares. Tables 6.6 and 6.7 present these elasticities for the four meat products for the different income groups.

In Table 6.6 for all income levels fish presents the larger expenditure share elasticities, being in most cases two times the ones presented by the other meat products. What this really means is that as total expenditures increase fish increases its share approximately two times more than the other meat products. Hence, in the four income levels, households allocate additional expenditures on meat products to fish. As the income of households goes from under $25,000 to over $75,000, purchases of beef increase while purchases of fish and pork decrease. For any income group, shares of poultry go down as total meat expenditures increase.

Table 6.7 shows that all price share elasticities are inelastic, except for fish under the highest income level. However, the degree of elasticity among the four meat products varies considering the four income groups. The impact of changes in the prices of the meat products on the respective expenditure market shares also presents variations. For all meat products, under the three income groups ranging from $25,000 to over $75,000, an increase in the price of the meat products corresponds to an increase on the market share. This can be justified by the decrease in the demand

Table 6.6: Expenditure share elasticities for meat products under the four income groups.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
η_1^w (beef)	0.003410	-0.002108	0.04466	0.08599
η_2^w (poultry)	-0.1799	-0.1795	-0.2727	-0.2164
η_3^w (pork)	0.1247	0.08916	0.08026	0.1033
η_4^w (fish)	0.2903	0.3230	0.2801	0.1007

Table 6.7: Price share elasticities (γ_{ij}) for meat products under the four income groups where j impacts i.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
γ_{11} (beef)	-0.05813	0.02136	0.2062	0.3752
γ_{12} (beef / poultry)	-0.04566	-0.04347	-0.07817	-0.1156
γ_{13} (beef / pork)	0.06462	0.03789	-0.07817	-0.1243
γ_{14} (beef / fish)	0.03576	-0.01367	-0.09454	-0.2212
γ_{22} (poultry)	0.1696	0.2299	0.3806	0.3576
γ_{21} (poultry / beef)	0.01265	0.01358	0.008809	-0.02953
γ_{23} (poultry / pork)	-0.04407	-0.07594	-0.09269	-0.08399
γ_{24} (poultry / fish)	0.04177	0.01197	-0.02380	-0.02788
γ_{33} (pork)	-0.01434	0.1175	0.4443	0.5865
γ_{31} (pork / beef)	0.07635	0.03741	-0.1824	-0.2359
γ_{32} (pork / poultry)	-0.1560	-0.2007	-0.2219	-0.2241
γ_{34} (pork / fish)	-0.03073	-0.04337	-0.1203	-0.2297
γ_{44} (fish)	-0.2199	0.08438	0.4935	1.0300
γ_{41} (fish / beef)	0.03860	-0.1650	-0.3774	-0.6238
γ_{42} (fish / poultry)	-0.006670	-0.1237	-0.1918	-0.1598
γ_{43} (fish / pork)	-0.1023	-0.1187	-0.2046	-0.3470

for the product due to the price increase being offset by the increase in total revenue through the price increase. Among the four meat products, beef is the one that is most inelastic. That is, the effect of changes in beef prices on their expenditure market shares are very low in comparison with the other three meat products. The gains in poultry, pork and fish market shares due to increase in price can be justified by the elasticities of demand for these products being less than one, or also defined as being inelastic. However, it is important to note that the relative impacts of prices on the expenditures shares are different among the four meat products due to the different magnitude of elasticities. Looking now at the cross price elasticities, with an increase in the price of poultry, there is a loss in market shares for beef, pork and fish. Faced with an increase on the price of pork, market shares of poultry and fish also go down, while in the case of beef there is an increase on the market share under the two lowest income levels. The market share of poultry goes up with an increase in the price of fish for income levels under $50,000.

Price Changes and Elasticities

So far in this chapter all demand elasticities for the four meat products under the different income groups were determined at mean values. A comparison of the uncompensated elasticities when deviations from the mean price are present will be shown. Price simulations are carried out by changing meat prices by 25 percent below and above the mean price. In each simulation, all other variables are kept at their mean values. Table 6.8 shows changes in uncompensated elasticities of the different meat products for households with an income level from $50,000 to $74,999 when price of beef is allowed to shift by 25 percent below and above the mean. In Table 6.8 as price of beef goes up, there is an increase in the sensitivity of the meat products to the price changes. Similar results are obtained under price fluctuations of the other meat products.

The effect of price fluctuations of the different meat types on the expenditure elasticities is shown in Table 6.9 with this table showing the case for households with incomes from $50,000 to $74,999. Similar results were obtained under the three other income groups. The price of each meat

product was allowed to shift by 25 percent below and above the mean and the respective expenditure elasticities were determined. In the case of beef, pork and fish, an increase in the own price is responsible for a decrease on the value of the expenditure elasticity. As the price of the meat product goes up, expenditure elasticities for poultry go up, although being less than unity, while for the other meat products go down. Overall, changing the price levels had little impact on the expenditure elasticities. That is, the elasticities were not that sensitive to the points on each demand curve.

Table 6.8: Uncompensated price elasticities (ϵ_{ij}) with different price levels for beef where j impacts i.

	25% below Mean price	Mean price	25% above Mean price
ϵ_{11} (beef)	-0.7796	-0.7938	-0.8037
ϵ_{21} (poultry / beef)	0.001696	0.008809	0.01429
ϵ_{31} (pork / beef)	-0.1714	-0.1824	-0.1919
ϵ_{41} (fish / beef)	-0.3341	-0.3774	-0.4185

Table 6.9: Expenditure elasticities after own price changes.

	25% below Mean price	Mean price	25% above Mean price
η_1 (beef)	1.047	1.045	1.043
η_2 (poultry)	0.6940	0.7273	0.7488
η_3 (pork)	1.092	1.080	1.073
η_4 (fish)	1.327	1.280	1.252

Demand and Market Share Elasticities for Scenario 2

In this section the compensated price elasticities of demand for the nine products are presented under the four income levels.

Price Elasticities

Price elasticities of demand, either uncompensated or compensated can be determined for the nine products from scenario 2. Table 6.10 presents the compensated price elasticities for the beef cuts, poultry cuts, pork and fish under the four income groups. The beef cuts include roasts, steaks, other beef cuts and ground beef, while the poultry cuts include chicken, turkey and other poultry cuts. In Table 6.10, going from the lowest income group to the highest there is a tendency for the values of the elasticities of the different meat types to increase. In general, the lowest own price elasticities are seen in the income group under $25,000. The effect of an increase in the price of steak on roast (ϵ_{12}=.105) is about two times higher than the effect of an increase in the price of roast on steak ((ϵ_{21}=.05).

Expenditures Simulation (Scenario 2)

In this section the interest is in analyzing the effects of the changes in meat expenditures on the allocation of shares among the four different beef cuts. Specifically, the allocation of expenditures among roast, steak, other types of beef and ground beef will be evaluated. Simulations were performed under the four different income levels with changes in meat expenditures in the range of 50 to 150 percent of the mean value of total meat expenditures. Figure 6.9 represents the distribution of beef expenditures on the four different types of beef under the lower income level, when expenditures on meat are at the mean value. As expenditures on meat decrease by 25 percent, from

Table 6.10: Compensated price elasticities (ϵ_{ij}) for nine products where j impacts i.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
ϵ_{11} (roast)	-1.51481	-0.43390	0.87519	1.69607
ϵ_{12} (roast / steak)	0.10512	-0.20286	-0.37899	-0.41560
ϵ_{13} (roast / other beef)	0.059384	-0.32626	-0.36045	-0.62820
ϵ_{14} (roast / ground beef)	0.51424	0.032298	-0.14814	-0.26456
ϵ_{15} (roast / chicken)	0.15180	0.15882	0.11365	-0.26785
ϵ_{16} (roast / turkey)	-0.00051754	0.12477	-0.11382	-0.046984
ϵ_{17} (roast / other poultry)	0.070097	0.043075	-0.031985	-0.10351
ϵ_{18} (roast / pork)	0.34953	0.41719	0.081242	0.25326
ϵ_{19} (roast / fish)	0.26517	0.18688	-0.036719	-0.22263
ϵ_{21} (steak / roast)	0.050435	-0.090342	-0.14654	-0.17057
ϵ_{22} (steak)	-1.06175	-0.68575	-0.055924	0.23388
ϵ_{23} (steak / other beef)	-0.094856	-0.076978	-0.10959	-0.092528
ϵ_{24} (steak / ground beef)	0.19181	0.14979	-0.059683	-0.065698
ϵ_{25} (steak / chicken)	0.17113	0.20659	0.084340	0.10648
ϵ_{26} (steak / turkey)	0.038024	0.022281	-0.022842	-0.064857
ϵ_{27} (steak / other poultry)	0.0025117	0.0099407	0.0041683	0.014720
ϵ_{28} (steak / pork)	0.50532	0.31742	0.24089	0.18880
ϵ_{29} (steak / fish)	0.19740	0.14704	0.065181	-0.15020
ϵ_{31} (other beef / roast)	0.12552	-0.57181	-0.52701	-0.59650
ϵ_{32} (other beef / steak)	-0.41790	-0.30294	-0.41441	-0.21407
ϵ_{33} (other beef)	-0.25173	1.05097	2.09803	1.66240
ϵ_{34} (other beef / ground beef)	0.62147	0.041603	-0.43804	-0.13823
ϵ_{35} (other beef / chicken)	0.27408	0.062031	0.12629	0.054373
ϵ_{36} (other beef / turkey)	-0.13009	-0.21209	-0.23582	-0.11656
ϵ_{37} (other beef / other poultry)	-0.032500	-0.13491	-0.13661	-0.14494
ϵ_{38} (other beef / pork)	0.14600	0.15130	-0.20740	-0.047447
ϵ_{39} (other beef / fish)	-0.33483	-0.084161	-0.26507	-0.45897
ϵ_{41} (ground beef / roast)	0.16888	0.013223	-0.051871	-0.092416
ϵ_{42} (ground beef / steak)	0.13129	0.13770	-0.054050	-0.055915
ϵ_{43} (ground bee / other beef)	0.096557	0.0097185	-0.10491	-0.050853
ϵ_{44} (ground beef)	-0.96008	-0.82479	-0.19447	0.13591
ϵ_{45} (ground beef / chicken)	0.21861	0.19092	0.20861	0.19400
ϵ_{46} (ground beef / turkey)	0.043415	0.10809	0.038321	-0.049864
ϵ_{47} (ground beef / other poultry)	0.013200	0.019927	-0.00064808	0.010902

Table 6.10: Continued.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
ϵ_{48} (ground beef / pork)	0.18452	0.25416	0.11022	0.020914
ϵ_{49} (ground beef / fish)	0.10364	0.091025	0.048787	-0.11266
ϵ_{51} (chicken / roast)	0.039927	0.038430	0.029162	-0.059943
ϵ_{52} (chicken / steak)	0.093821	0.11225	0.055969	0.058057
ϵ_{53} (chicken / other beef)	0.034107	0.0085644	0.022162	0.012815
ϵ_{54} (chicken / ground beef)	0.17509	0.11284	0.15287	0.12429
ϵ_{55} (chicken)	-0.61034	-0.46240	-0.35420	-0.27954
ϵ_{56} (chicken / turkey)	0.059100	0.039314	0.034374	0.065010
ϵ_{57} (chicken / other poultry)	0.0031700	0.0035720	-0.0036371	-0.010066
ϵ_{58} (chicken / pork)	0.093137	0.068863	0.0086680	0.014429
ϵ_{59} (chicken / fish)	0.11200	0.078556	0.054632	0.074960
ϵ_{61} (turkey / roast)	-0.00046259	0.11839	-0.17282	-0.030848
ϵ_{62} (turkey / steak)	0.070841	0.047473	-0.089703	-0.10375
ϵ_{63} (turkey / other beef)	-0.055011	-0.11483	-0.24491	-0.080598
ϵ_{64} (turkey / ground beef)	0.11816	0.25052	0.16617	-0.093723
ϵ_{65} (turkey / chicken)	0.20083	0.15416	0.20342	0.19073
ϵ_{66} (turkey)	-0.73609	-0.57399	0.39407	0.0014939
ϵ_{67} (turkey / other poultry)	0.045728	0.0037972	0.044699	0.042907
ϵ_{68} (turkey / pork)	0.11566	0.017691	-0.27242	-0.013236
ϵ_{69} (turkey / fish)	0.24035	0.096777	-0.028529	0.087045
ϵ_{71} (other poultry / roast)	1.07426	0.72459	-0.55814	-0.74966
ϵ_{72} (other poultry / steak)	0.080230	0.37548	0.18811	0.25975
ϵ_{73} (other poultry / other beef)	-0.23564	-1.29486	-1.63041	-1.10550
ϵ_{74} (other poultry / ground beef)	0.61602	0.81875	-0.032296	0.22604
ϵ_{75} (other poultry / chicken)	0.18470	0.24832	-0.24735	-0.32578
ϵ_{76} (other poultry / turkey)	0.78403	0.067318	0.51369	0.47329
ϵ_{77} (other poultry)	-3.29563	-0.37083	1.64947	1.49115
ϵ_{78} (other poultry / pork)	0.30148	-0.015339	0.27908	-0.46041
ϵ_{79} (other poultry / fish)	0.49057	-0.55344	-0.16215	0.19115
ϵ_{81} (pork / roast)	0.10138	0.12044	0.024119	0.061817
ϵ_{82} (pork / steak)	0.30548	0.20577	0.18496	0.11228
ϵ_{83} (pork / other beef)	0.020033	0.024923	-0.042113	-0.012196
ϵ_{84} (pork / ground beef)	0.16296	0.17922	0.093450	0.014614
ϵ_{85} (pork / chicken)	0.10270	0.082158	0.010029	0.015737

Table 6.10: Continued.

	Under $25,000	$25,000 to $49,999	$50,000 to $74,999	Over $75,000
ϵ_{86} (pork / turkey)	0.037530	0.0053827	-0.053263	-0.0049206
ϵ_{87} (pork / other poultry)	0.0057055	-0.00026326	0.0047479	-0.015517
ϵ_{88} (pork)	-0.78584	-0.72825	-0.32015	-0.18415
ϵ_{89} (pork / fish)	0.050058	0.11060	0.098211	0.012355
ϵ_{91} (fish / roast)	0.16252	0.092761	-0.015065	-0.077639
ϵ_{92} (fish / steak)	0.25216	0.16389	0.069164	-0.12762
ϵ_{93} (fish / other beef)	-0.097083	-0.023835	-0.074382	-0.16856
ϵ_{94} (fish / ground beef)	0.19341	0.11036	0.057164	-0.11247
ϵ_{95} (fish / chicken)	0.26096	0.16114	0.087357	0.11681
ϵ_{96} (fish / turkey)	0.16480	0.050625	-0.0077087	0.046233
ϵ_{97} (fish / other poultry)	0.019618	-0.016331	-0.0038124	0.0092043
ϵ_{98} (fish / pork)	0.10578	0.19016	0.13573	0.017652
ϵ_{99} (fish)	-1.06214	-0.72877	-0.24844	0.29640

$33.95 to $25.46 of meat, the shares of roast and steak decrease, while the share of ground beef goes from 46.12 percent to 48.98 percent. There is a slight increase on the share of other types of beef (Figure 6.10). On the other hand side, faced with a 25 percent increase in the expenditures on meat, the shares of roast and steak increase, while the share of ground beef decreases from 46.12 percent to 43.89 percent (Figure 6.11). Once again, the change in the share of other types of beef is relatively small. In conclusion, the consumption of roasts and steaks for households with income level under $25,000 increases with an increase on meat expenditures. On the other hand side, under the same income level, the consumption of ground beef and other types of beef decreases as meat expenditures increase. In terms of the overall beef share, as the expenditures on meat go from 50 percent to 150 percent of the mean value, the beef shares change slightly from 39.83 percent to 39.49 percent. For households with an income level between $25,000 and $75,000 the consumption of steak and roast also increases under a higher amount of expenditures on meat. Contrary to what happened under the

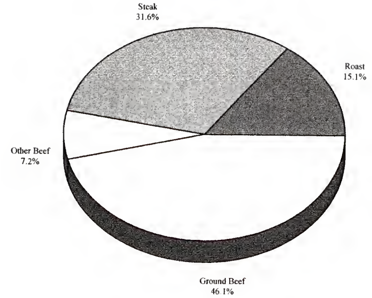

Figure 6.9: Distribution of beef expenditures at the mean value of total meat expenditures (under $25,000).

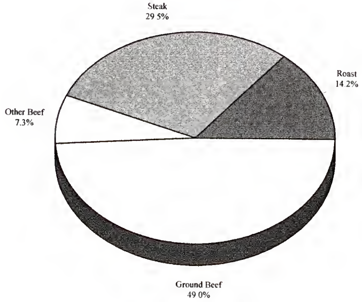

Figure 6.10: Distribution of beef expenditures 25 percent below the mean value of total meat expenditures (under $25,000).

lowest income level, the consumption of other types of meat also increases. Under all the income levels, the share of ground beef decreases with an increase in meat expenditures. The most pronounced effect is seen under the income level ranging from $25,000 to $50,000, where the share of ground beef decreases by 15.01 percentage points, from 48.46 percent to 33.45 percent as the expenditures on meat increase from 50 percent to 150 percent of the mean value. In terms of beef share variations across the different meat expenditures, the most pronounced effect is seen under the higher income groups with an increase of 3.6 percentage points as expenditures go from 50 to 150 percent of the mean value. Table 6.11 shows the distribution of the beef shares across the four beef cuts for different income levels, when the meat expenditures are at the mean value. Among the four beef cuts, ground beef accounts for the highest amount with a 46.12 percent of the beef share among the households with an income level under $25,000 a year. The consumption of steak appears in second place with a 31.57 percent of the beef share, followed by the consumption of roast with a 15.15 percent of the beef share for households with an income level under $25,000 a year. As the income of the households increases, going from under $25,000 a year to between $25,000 and $75,000 a year, there is an increase on the consumption of other types of beef and a decrease in the consumption of ground beef. For instance the ground beef share decreases by 7.18 percentage points from 46.12 percent to 38.94 percent, while the share of other types of beef increases by 7.16 percentage points from 7.16 percent to 14.32 percent. The consumption of roast and steak fluctuates across the different income groups. Also, among the four income groups, the beef share fluctuates between 39.61 percent for the income level under $25,000 a year and 35.96 percent for the income level above $75,000 a year.

As the meat expenditures go from 50 percent to 150 percent of the mean value, poultry share decreases under the four income groups. The most pronounced effect is seen under the income group ranging from $50,000 to $75,000 with a decrease of 8.22 percentage points in the poultry market

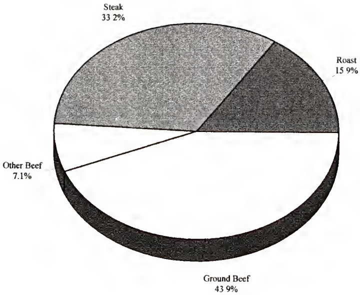

Figure 6.11: Distribution of beef expenditures 25 percent above the mean value of total meat expenditures (under $25,000).

Table 6.11: Distribution of beef shares across the for income levels.

	Roast	Steak	Other Beef	Ground Beef	Total
under $25,000	15.15%	31.57%	7.16%	46.12%	100.00%
$25,000 to $49,999	15.98%	35.88%	9.12%	39.02%	100.00%
$50,000 to $74,999	14.03%	36.29%	9.60%	40.08%	100.00%
over $75,000	13.60%	33.14%	14.32%	38.94%	100.00%

share. In terms of the three poultry cuts, as meat expenditures increase, for all income groups, except the one under $25,000, there is an increase on chicken consumption. The largest change in chicken share occurs under the income level from $50,000 to $75,000 with a increase on share from 80.45 percent to 87.67 percent as meat expenditures go from 50 to 150 percent of the mean value. Within

the same income group, turkey share decreases by 7.69 percentage points from 18.57 percent to 10.88 percent.

Price Simulation

In order to analyze the effect of changes in the price of beef on the shares of the different beef cuts, the prices of all beef cuts were allowed to shift between 15 percent below and above the mean price, of each cut while holding all other meat prices at their mean. Figures 6.12 through 6.14 include the distribution of the beef shares among the four beef cuts, faced with a change in the prices of each beef cut. As the price of beef increases from 15 percent below the mean price to 15 percent above the mean price there is a decrease of 1.2 percentage points in the share of roast, while the share of steak decreases by 3.2 percentage points. The consumption of ground beef increases from 44.7 percent to 47.4 percent with the same price increase. Under the income level ranging from $25,000 to $50,000, there is a decrease in the share of roast and steak and an increase in the share of ground beef and other types of beef with an increase in the mean price of beef. Under the higher income levels, ranging from $50,000 to over $75,000 there is an increase in the share of roast and other types of beef and a decrease in the share of steak and ground beef. As the price of each poultry cut increases from 85 percent to 115 percent of the mean price of poultry, there is a decrease in the market share for chicken and an increase in the share of turkey and other types of poultry under the higher income groups. In all the income groups, chicken accounts for more than three quarters of the total poultry share.

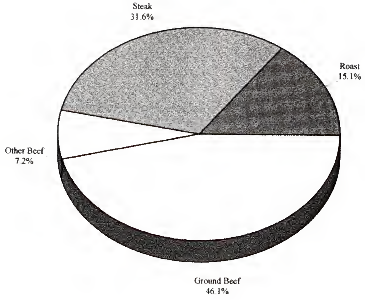

Figure 6.12: Distribution of the beef shares at the mean price of each cut (income under $25,000).

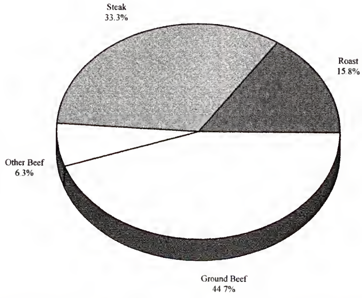

Figure 6.13: Distribution of the beef shares at 15 percent below the mean price of each cut (income under $25,000).

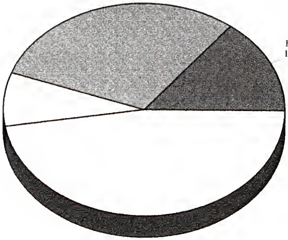

Figure 6.14: Distribution of the beef shares at 15 percent above the mean price of each cut

This chapter concentrated on a more detailed interpretation of the coefficient estimates presented in Chapter 5. First demand curves for the four meat products in all income groups were negatively sloped and relatively inelastic. However, price elasticities differed among income groups for each meat product. Higher inelastic demands were seen under households with higher income levels. Expenditures simulation were carried out and market shares gained by beef, pork and fish were at the expense of poultry.

In both uncompensated and compensated price elasticities, there was a decrease in price responses with increasing income levels. Little substitutability was seen between fish and the other meat products, while beef showed the highest degrees of substitutability with poultry, pork and fish.

Poultry had the lowest expenditure elasticities among the four meat products, while fish had the highest. Small differences were seen in the expenditure elasticities across the income groups.

Beef, pork and fish increased their shares if total meat expenditures increased. All meat products increased their revenue under the income groups ranging from $25,000 to over $75,000 if their prices were raised keeping prices of the other meat products constant. This result is not surprising due to the inelastic demand presented by these meat products.

In Chapter 7 the impact of the different demographics and seasonality on the meat budget shares will be analyzed.

CHAPTER 7
DEMOGRAPHIC SIMULATIONS

As part of the empirical measurement of the demand for different meat products it is essential to analyze the impact of major demand factors, and particularly the demographic variables. In Chapter 2 several types of expenditure allocation models were reviewed, with the AIDS model selected for this analysis. Chapter 3 dealt with a description of the data, and consumer statistics were determined. In Chapter 4 the AIDS model was specified and discussed for either four meat products or nine meat products. Different scenarios were also presented. The AIDS model was estimated and the empirical results were presented in Chapter 5.The different model coefficients were divided into six groups: demographic effects, seasonality effects, health effects, promotional and advertizing effects, price effects, and expenditure effects. In Chapter 6 the different demand and market share elasticities were calculated and presented. This helped with the interpretation of the coefficient estimates previously determined in Chapter 5.

This chapter deals with the impact of the different demographic variables on the budget shares. Simulation analyses are used to show their impacts on household demand for meat products. The demographic variables include five categories: household size, age of female, female employment level, female education level and market size. The effect of seasonality on the meat demand will also be taken into consideration. In order to show what is driving the demand for each meat product and the direction of change, the different demographics will be ranked in terms of their relative effects on demand. Several policy implications will be set forth as the simulation results are presented.

Comparison Among the Different Scenarios

The budget shares for the four meat products (scenario 1) across the different exogenous variables and under the four income groups ranging from under $25,000 to over $75,000 are presented in Appendix C (Tables C.1 through C.4). Tables 7.2 through 7.5 show the budget shares for the nine meat products (scenario 2) across the variables and income groups. As it was already described in Chapter 4, in the estimation of the AIDS model, different scenarios were considered taking into account the number of meat products included in the study, the consumption of all meat products during a particular time period, the number of times an individual household reports and the time of the survey. These different scenarios facilitate the comparison of the different household consumption possibilities. In order to make a comparison among the different scenarios, budget shares of the four meat products were determined.

Table 7.1 presents differences in percentage points between the shares obtained for beef across the different exogenous variables under the different scenarios. The income level considered in this comparison is for the lowest group, under $25,000 a year. The results are similar when considering the other three income groups. Comparing scenarios 3 and 1, the difference among the shares is under seven percentage points. The same difference can be observed when comparing scenarios 7 and 5. Consumption of the four meat products for the same time period and the resulting shares show little change when the household is reporting at least one time during the time of the survey or at least two times. With the consumption of the four meat products at the same time period or the consumption of any combination of the four meat products during a certain time period, columns 4 and 6 in Table 7.1 show little numerical differences (under 2 percentage points). When looking at the other three meat products and at the other three income groups, results showed little numerical differences among the shares obtained under the different scenarios. Given these results,

Table 7.1: Percentage point changes in budget shares attributed to different scenarios for beef across different exogenous variables (income level under $25,000).

Scenarios		3 - 1	5 - 1	7 - 5	7 - 3
Average consumer		-4.55	0.62	-4.03	1.13
Household size(number of people)	1	-5.39	1.00	-5.55	0.84
	2	-4.43	0.79	-3.49	1.73
	3	-3.87	0.75	-3.78	0.84
	4 plus	-4.51	-0.08	-3.31	1.11
Age of female (years)	29 and under	-4.18	1.07	-3.54	1.72
	30 to 49	-5.85	0.42	-5.18	1.09
	over 50	-3.62	0.35	-3.38	0.59
Female employment level (hours)	unemployed	-4.48	0.91	-3.73	1.67
	0 to 30	-3.66	0.14	-3.36	0.44
	over 30	-5.51	0.79	-5.01	1.29
Female education level	high school	-6.57	-0.12	-6.16	0.28
	college	-5.89	2.12	-6.84	1.18
	post college graduate	-1.19	-0.15	0.90	1.94
Census region	east	-2.82	0.85	-2.33	1.34
	central	-5.33	0.89	-5.37	0.85
	south	-5.38	0.41	-4.87	0.93
	west	-4.67	0.30	-3.56	1.41
Market size(number of people)	0 to 49,999	-4.69	0.43	-3.93	1.20
	50,000 to 249,999	-4.55	1.09	-4.75	0.90
	over 250,000	-4.40	0.32	-3.42	1.31
Seasonality (quarters)	January-March	-4.45	0.12	-3.89	0.67
	April-June	-5.69	0.71	-5.16	1.25
	July-September	-5.12	1.15	-4.85	1.42
	October-December	-2.95	0.48	-2.23	1.19

scenario 1 was analyzed in more detail. For the nine meat products, similar comparisons were made among the different scenarios. Small numerical differences were seen among the meat shares across the different scenarios, hence scenario 2 was selected for further consideration of the nine products.

Demographics Effects (Scenario 1)

The major demographics and seasonality expected to have an impact on the household demand for meat products were defined in Table 3.3 in Chapter 3. Demographics and seasonality were shown to have a statistically significant impact on each meat types as presented in Tables 5.1 through 5.8 (Chapter 5) with the AIDS estimates. Their impact on the allocation of household expenditures shares among the different meat products will be evaluated. Using the coefficient estimates (Chapter 5) and equation (4.3), the budget shares of the different meat products were determined at the mean values of prices and total meat expenditures for all the exogenous variables (Appendix B). Tables C.1 through C.4 in Appendix C present the budget shares of the four products across the different demographics and four income groups. In each simulation the shares of the meat products are shown for each income group and under the various categories of demographics, and seasonality.

While the actual simulated values are presented in Appendix C, in the subsequent discussions more details for each demographic variable are presented. Using some of the values from these tables, several graphs will be presented to fully illustrate the impacts of the different demographics (Figures 7.1 through 7.20). Although the simulations are in terms of shares of meat expenditures, since prices are fixed when doing the demographics the change in shares must be attributed to changes in consumption.

Female Age

Age of the female and female employment status are two demographic variables expected to be closely aligned with the need for convenience during the buying occasion. As presented in Table 3.3 (Chapter 3), ages of female range from less than thirty years to over fifty years old. For these ranges the simulated effects on the meat shares for the four income levels are presented in Figures 7.1 through 7.4. As the female gets older there is a decrease on the consumption of beef (Figure 7.1) in the case of the households with an income level under $25,000 a year and between $25,000 and $50,000. Specifically, in the lowest income groups there is a decrease in beef shares of 5.3 percentage points from 42.21 percent 36.92 percent. For households with higher income levels, the consumption of beef is relatively stable across the three age groups. Note also that the beef share among the higher income groups is consistently lower than for the lower income groups. In the case of poultry the biggest changes on the shares across the three age groups occur under the income level over $75,000 with a drop in the share for poultry by 6.3 percentage points from 33.04 percent to 26.79 percent (Figure 7.2). In the other three income groups, poultry shares remain relatively stable. Pork shares across the three age groups increases under the four income groups (Figure 7.3). The highest change occurs under the highest income group with the share of pork going from 15.27 percent to 23.30 percent as the age of the female goes from under 30 years old to over 50 years old. Among the four meat products, fish presents the lowest share values. In the income group under $25,000 fish consumption is under 10 percent, while the market share for fish is above 15 percent among households under 30 years old and with an income level between $50,000 and $75,000 a year. There is a slight drop in household fish share as the age of household goes from under 30 years old to between 30 and 50 years old.

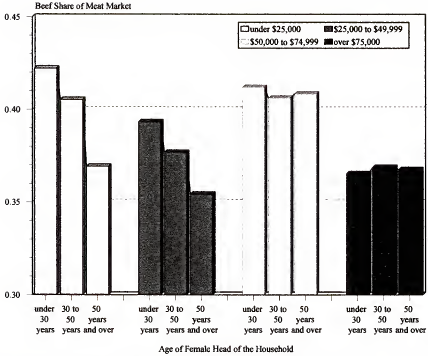

Figure 7.1: Beef share of meat market for different demographic groups (age of female) across four income levels.

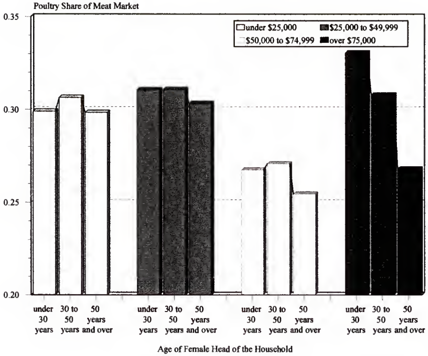

Figure 7.2: Poultry share of meat market for different demographic groups (age of female) across four income levels.

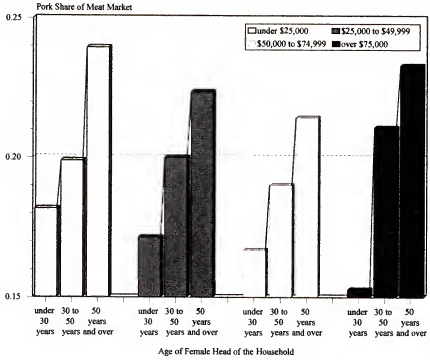

Figure 7.3: Pork share of meat market for different demographic groups (age of female) across four income levels.

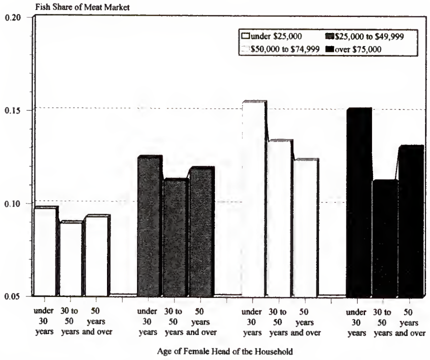

Figure 7.4: Fish share of meat market for different demographic groups (age of female) across four income levels.

Female Employment Level

Female employment status ranges from unemployed to working over thirty hours per week. The simulated effects of this variable on the meat products for the four income levels are presented in Figures 7.5 through 7.8. The share of beef, pork and fish increases, as the female employment ranges from unemployed to working full time (i.e, over thirty hours a week). For beef and fish, the highest shares can be seen under the income level ranging from $50,000 to $75,000 per year. This result is somewhat contrary to initial expectations. If one argues that beef and fish are less convenient products, then their demand would decrease as employment level increases.

As it was already referred, both beef, pork and fish shares increased with the employment status, while the poultry share declined. The beef results in particular are contrary to what has been seen by another study done by Ward using a different panel data set.

Household Size

Household sizes ranged from one person to four or more people. Both beef and poultry demand increase with larger households while pork and fish demand declines (Figures 7.9 through 7.12). The only exceptions are with a decrease in the share of poultry under the second income group ranging from $25,000 to $50,000 and with an increase in the share of pork under the income group between $50,000 and $75,000. The highest variation on the beef share occurred under the income group ranging from $25,000 to $50,000 with an increase of 10.77 percentage points as the number of members in the household goes from one to four or more. In the case of poultry and fish, the highest share variations were in the third income group. As the household size went from one to four or more members, poultry share increased by 9.02 percentage points from 20.51 percent to 29.53

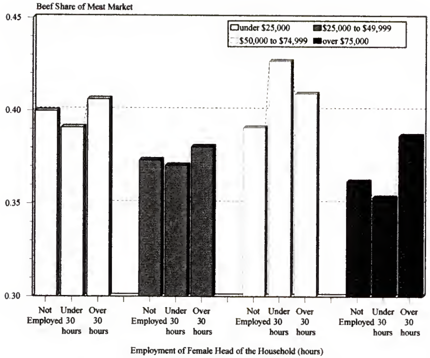

Figure 7.5: Beef share of meat market for different demographic groups (female employment level) across four income levels.

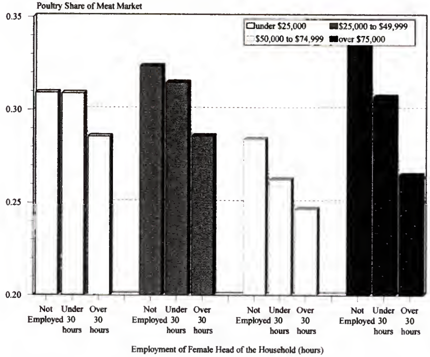

Figure 7.6: Poultry share of meat market for different demographic groups (female employment level) across four income levels.

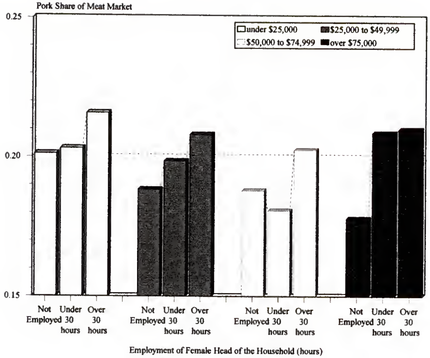

Figure 7.7: Pork share of meat market for different demographic groups (female employment level) across four income levels.

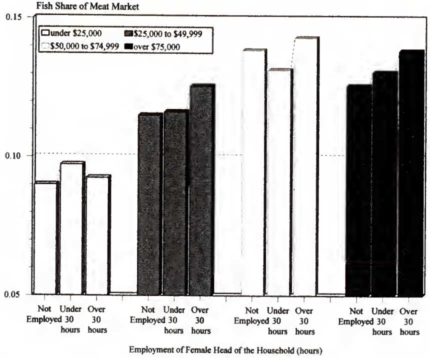

Figure 7.8: Fish share of meat market for different demographic groups (female employment level) across four income levels.

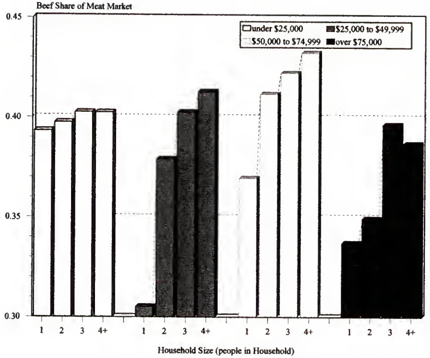

Figure 7.9: Beef share of meat market for different demographic groups (household size) across four income levels.

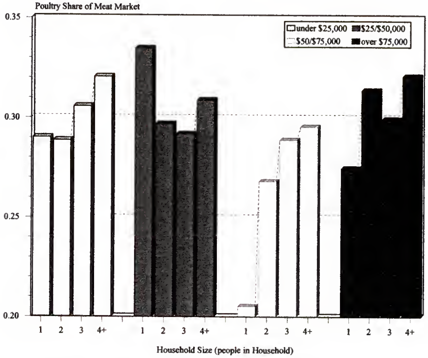

Figure 7.10: Poultry share of meat market for different demographic groups (household size) across four income levels.

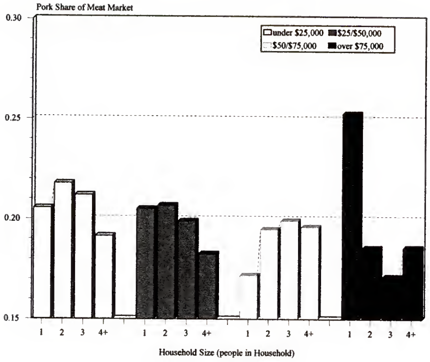

Figure 7.11: Pork share of meat market for different demographic groups (household size) across four income levels.

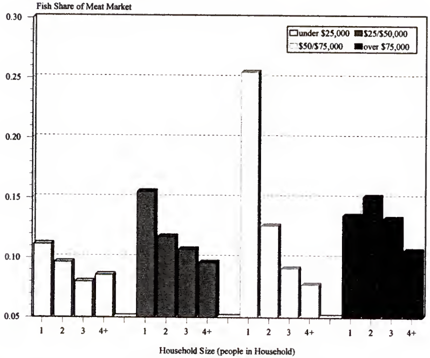

Figure 7.12: Fish share of meat market for different demographic groups (household size) across four income levels.

percent, while fish share went down from 25.48 percent to 7.74 percent, i.e, by 17.74 percentage points.

Female Education Level

Education of the female head of the household ranged from high school (lowest range) to post graduate (highest range). From Figures 7.13 through 7.16, education is shown to have a negative impact on both beef and pork demand. The results for poultry are just the opposite, with an increase in demand among females with higher levels of education. In the case of fish, there is little variation across the three education levels, except under the second income group. Most of the shift attributed to educational differences is with lower consumption of beef and pork with poultry benefitting from the change.

Market Size

Community sizes varied between rural areas, with less than 50,000 people and cities with more than 250,000 people. Changes in the market shares of the four meat cuts occur across the different areas (Figures 7.17 through 7.20). The household income level also plays a role in the distribution of the shares among beef, fish, poultry and pork (see Appendix C: Tables C.1 through C.4). Among all the income groups, not including the highest one, there is an increasing trend in the consumption of poultry and fish in the more populated areas.

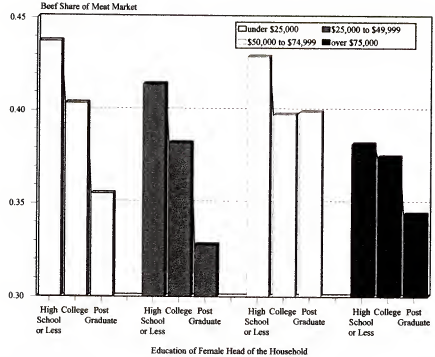

Figure 7.13: Beef share of meat market for different demographic groups (female education level) across four income levels.

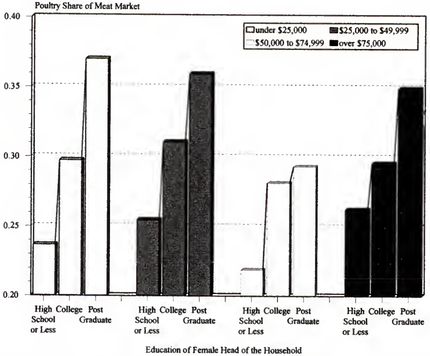

Figure 7.14: Poultry share of meat market for different demographic groups (female education level) across four income levels.

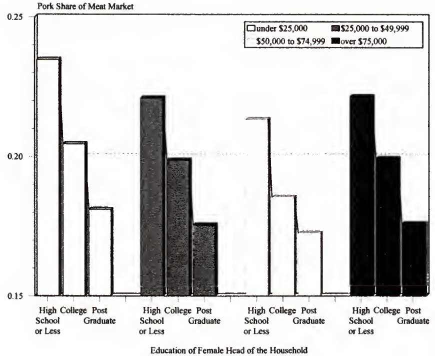

Figure 7.15: Pork share of meat market for different demographic groups (female education level) across four income levels.

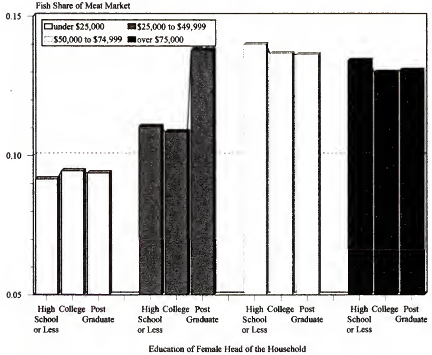

Figure 7.16: Fish share of meat market for different demographic groups (female education level) across four income levels.

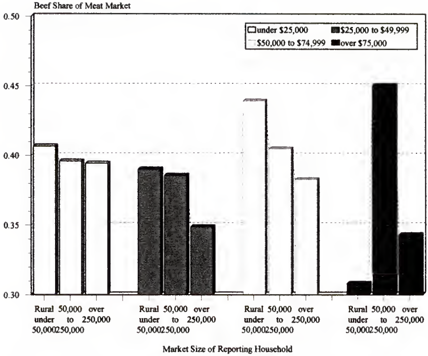

Figure 7.17: Beef share of meat market for different demographic groups (market size) across four income levels.

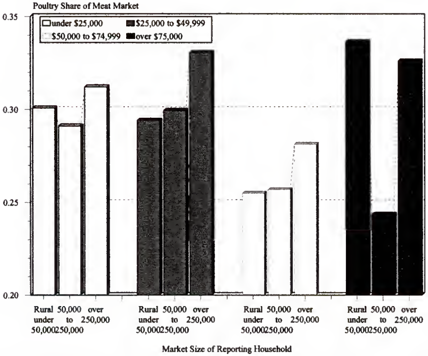

Figure 7.18: Poultry share of meat market for different demographic groups (market size) across four income levels.

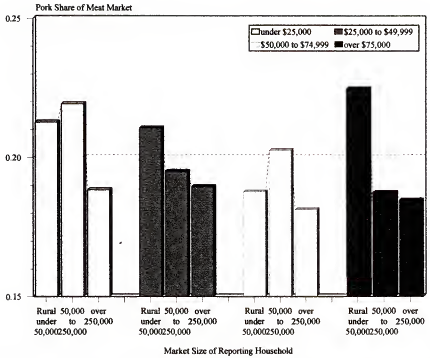

Figure 7.19: Pork share of meat market for different demographic groups (market size) across four income levels.

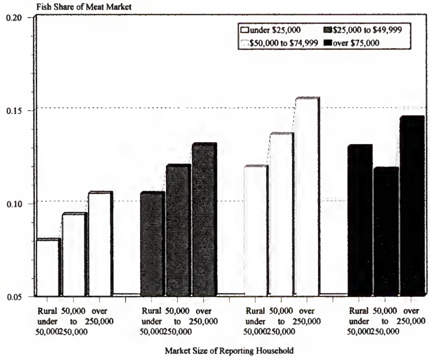

Figure 7.20: Fish share of meat market for different demographic groups (market size) across four income levels.

Seasonality

Seasonality is also representative of household behavior on the consumption of meat products, where purchasing patterns are closely tied to customs of different consumers and to special occasions. Seasonal differences are shown with quarter changes in the consumption of the four meat products (Figures 7.21 through 7.24). The most pronounced effects are seen during Thanksgiving and Christmas periods with an increase on poultry consumption and a decrease on both beef and fish demand. Beef shares decrease from the third to the fourth quarter of the year by around seven percentage points and fish shares by approximately two percentage points. Poultry shares increase during the holiday periods by approximately six percentage points. During the other three quarters, from January through September, the shares of the meat products remain relatively stable, or at least there is no accentuated seasonality beyond that for the year ending months.

Ranking Demand Shifters (Scenario 1)

In order to show what is driving changes in consumer demand for meat products, the impacts from the different demographics and seasonality were ranked according to the resulting changes in the market shares. This procedure is useful in that the impact from changing any combination of demographics can be expressed relative to the average consumer. The R values represent the difference between the share of a certain meat product and the share for the average consumer. These values can be compared within a particular demographic as well as across demographics since in every case they are relative to the same base, the average household.

Figures 7.25 through 7.28 represent indexed shifts in the demand of beef relatively to the average consumer for the four income groups respectively. The arrows indicate the directional effect,

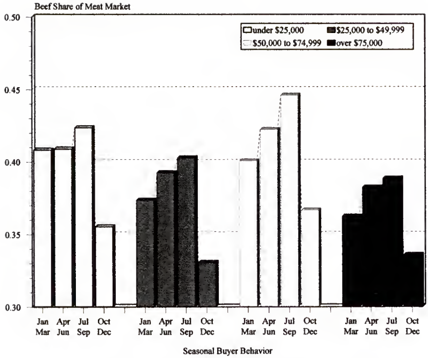

Figure 7.21: Beef share of meat market for different demographic groups (seasonality) across four income levels.

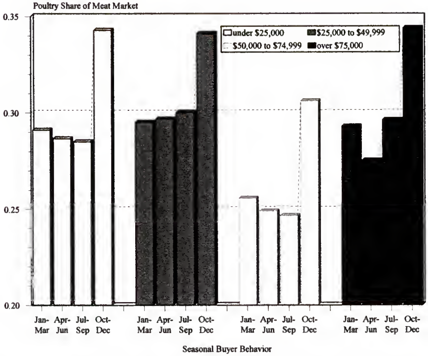

Figure 7.22: Poultry share of meat market for different demographic groups (seasonality) across four income levels.

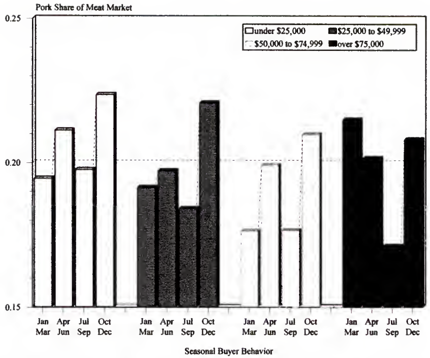

Figure 7.23: Pork share of meat market for different demographic groups (seasonality) across four income levels.

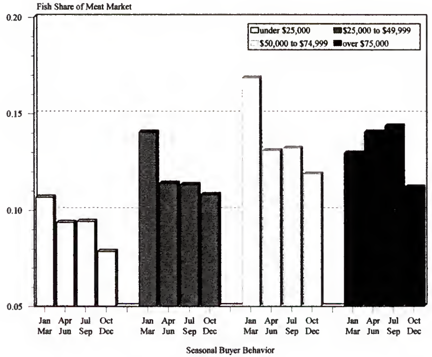

Figure 7.24: Fish share of meat market for different demographic groups (seasonality) across four income levels.

this is, if the demand for the meat type in question increases or decreases going from the lowest range to the highest range of the exogenous variable being analyzed. As the R values are determined relatively to an average consumer, the ranking of the different exogenous variables, including demographics and seasonality, is comparable across the four income groups for each meat type. This way, one can analyze what is the driving changes in consumers purchasing decisions for meat products as well as the direction of change.

Simulations provide a ready tool for predicting change and to identify where markets should be targeted if an industry wants to address negative effects. In Figure 7.25 female education shows the impact in beef demand with a seven percentage points range. As the level of education of the female increases from high school to post college graduate, there is a seven percentage point decrease on the beef share. Age of female also plays an active role on the demand for beef among the households with an income level under $25,000. Comparing females under 29 years of age with those over 50 years, there is a 5.3 percentage point decrease on the beef share. The effects of household size, female employment level, and market size on beef demand is lower, as also seen in Figure 7.25 (i.e., smaller ranges of changes between the lowest demographic variable and the highest). As already seen, beef demand increases as household size and female employment levels go up, while as the community size increases there is a decrease on the beef demand. For the income group ranging from $25,000 to $49,999, household size plays the most important role. After indexing to the average household, there is a 10.76 percentage points spread between household sizes with one member compared to four or more members with the demand increasing as the household size increases. The effect of female education is next with a 8.66 percentage point spread, followed with female age and market size each having approximately a four percentage point spread. Education, age, and market size all have a negative impact, going from the lowest to the highest measures of each demographic. In the higher income levels, household size, market size and female employment level have the major

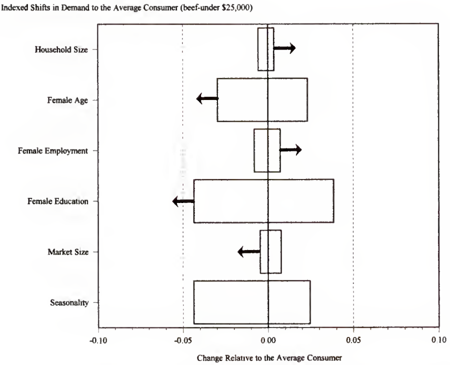

Figure 7.25: Ranking of the exogenous variables on beef demand for households with an income level under $25,000.

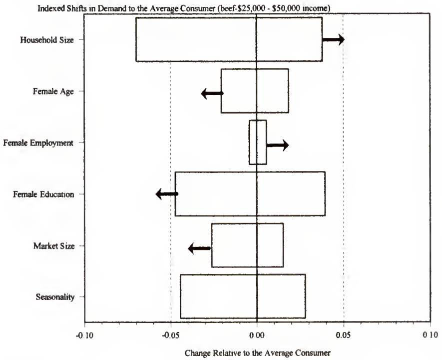

Figure 7.26: Ranking of the exogenous variables on beef demand for households with an income level between $25,000 and $50,000.

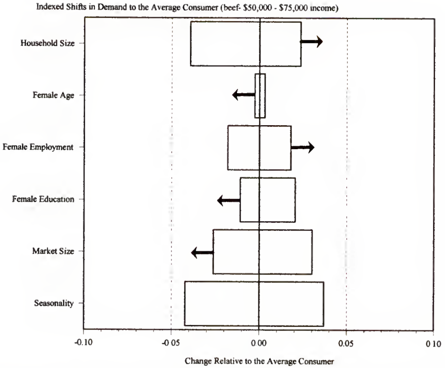

Figure 7.27: Ranking of the exogenous variables on beef demand for households with an income level between $50,000 and $75,000.

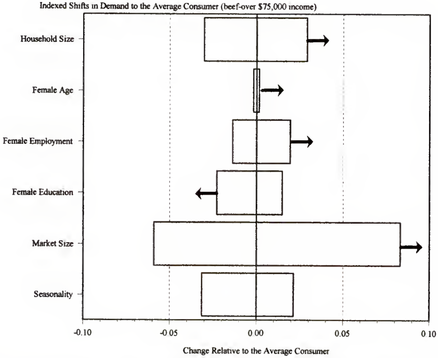

Figure 7.28: Ranking of the exogenous variables on beef demand for households with an income level over $75,000.

impact on beef demand. For households with an income level between $50,000 and $74,999, household size comes first with a 6.30 percentage point range of change between families with just one household member and four household members. Market size is the first demographic ranked among the highest income level households with a 14.23 percentage point spread. Among the four income groups, household size is particularly important for households with an income level between $25,000 and $50,000, age and education for households with low income levels and female employment for households with high income levels. Market size, in opposite to what occurs under the three lower income levels, has the greatest impact among the highest income group with an increase on beef demand in the more populated areas. Seasonality in beef demand is present in all income groups.

The different demographics and seasonality can also be ranked in terms of their impact on poultry consumption (Figures 7.29 through 7.32). Education is particular important under households with an income level under $25,000 a year with a 13.35 percentage point spread between the lowest and the highest education level, this is between a high school education and a post college graduate education. As the education level increases, there is a greater demand for poultry. In all the income levels except the one from $50,000 to $75,000, demand for poultry goes up with household size. Household size is particular significant under the income level of $50,000 to $75,000 a year. The greatest impact of both female employment and age occur under the highest income group with a 6.94 and 6.25 percentage point spread respectively. In both of these demographics there is a decrease in poultry demand with an increase in the demographic level. As already seen with beef, market size is particularly relevant under the households with the highest income level with a 9.28 percentage point spread. In contrast, poultry consumption decreases as the market size area goes from under 50,000 to over 250,000 people.

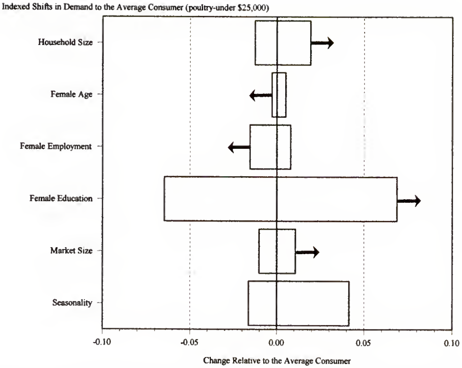

Figure 7.29: Ranking of the exogenous variables on poultry demand for households with an income level under $25,000.

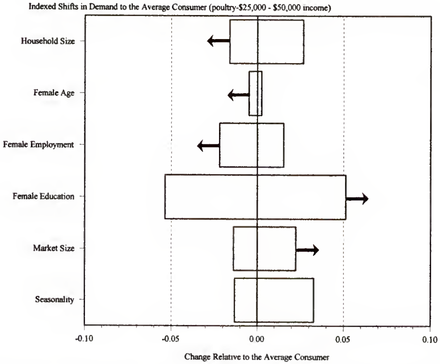

Figure 7.30: Ranking of the exogenous variables on poultry demand for households with an income level between $25,000 and $50,000.

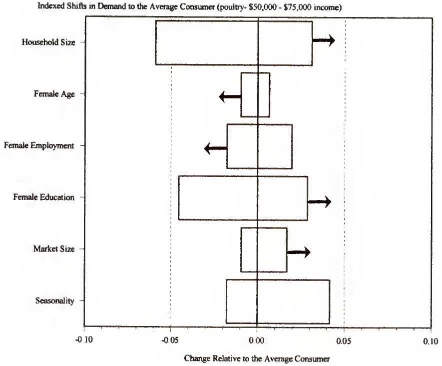

Figure 7.31: Ranking of the exogenous variables on poultry demand for households with an income level between $50,000 and $75,000.

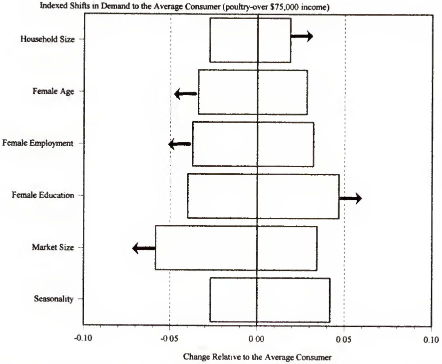

Figure 7.32: Ranking of the exogenous variables on poultry demand for households with an income level over $75,000.

The consumption of poultry by households of all income levels increases during the last quarter and is most likely. This can be attributed to the Thanksgiving and Christmas holiday periods.

Looking now at pork consumption (Figures 7.33 through 7.36) for income levels under $75,000 female age has the highest impact on the demand for this meat type. As the female becomes older, there is an increase on the demand for pork. Under this same income range, education is next in its impact where as the female becomes more educated there is a decrease on the demand for pork. The education effect is contrary to what was seen on the demand for poultry. Household size is the most relevant variable under the highest income level. As the number of members per household increases, the demand for pork products declines. Among all the income groups, household size, age, female employment, and market size have the highest effect among households with income over $75,000 a year whereas, female education has the highest impact among households with income under $25,000 a year.

Finally, Figures 7.37 through 7.40 include the ranking of the different exogenous variable for the consumption of fish. In all the income levels, the demographic having the highest impact on fish demand is household size. The biggest impact of household size occurs in the income level between $50,000 and $75,000. As the number of people per household increases, there is a decrease in the demand for fish. This is particularly attributed to the higher price of fish in comparison with the other three meat types. Female age and female employment are particular important in the highest income group. In general, the effects of the different demographics and seasonality are lower on the demand for fish. During the holiday periods of Thanksgiving and Christmas there is a decrease on the demand for beef and fish and an increase on the demand for poultry and pork.

In conclusion, having a precise empirical measure of what is driving consumers purchasing decisions is fundamental to making long term risk management decisions. As shown in this section the impacts can be expressed by ranking the demand drivers. These comparisons point to household

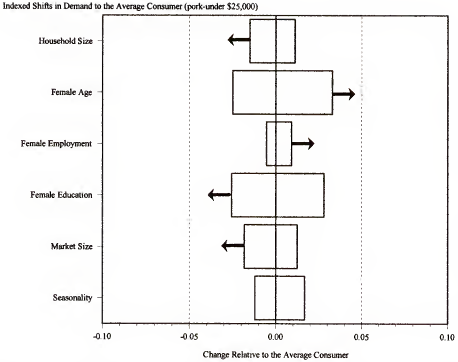

Figure 7.33: Ranking of the exogenous variables on pork demand for households with an income level under $25,000.

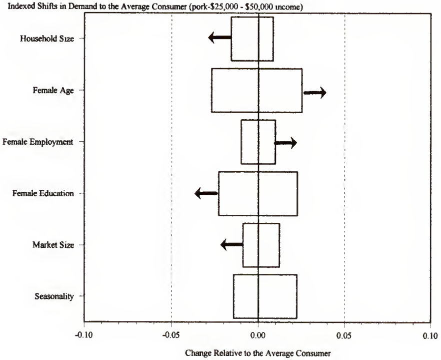

Figure 7.34: Ranking of the exogenous variables on pork demand for households with an income level between $25,000 and $50,000.

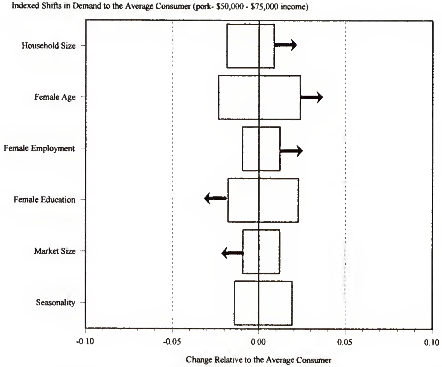

Figure 7.35: Ranking of the exogenous variables on pork demand for households with an income level between $50,000 and $75,000.

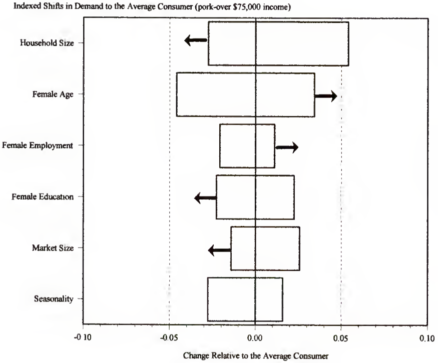

Figure 7.36: Ranking of the exogenous variables on pork demand for households with an income level over $75,000.

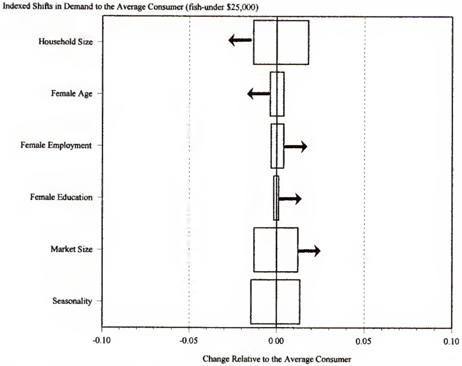

Figure 7.37: Ranking of the exogenous variables on fish demand for households with an income level under $25,000.

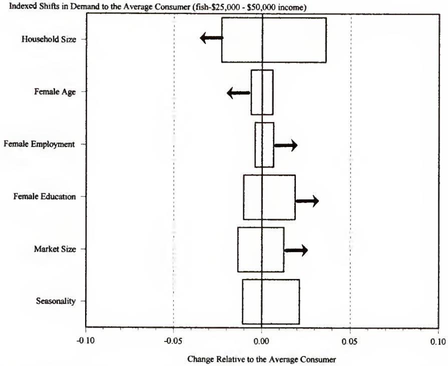

Figure 7.38: Ranking of the exogenous variables on fish demand for households with an income level between $25,000 and $50,000.

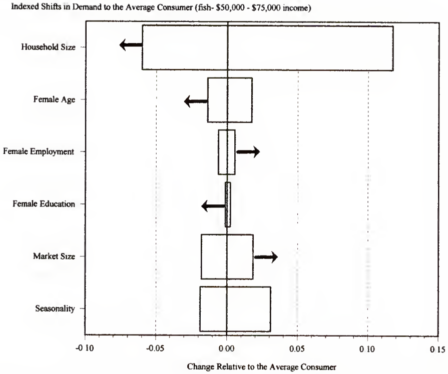

Figure 7.39: Ranking of the exogenous variables on fish demand for households with an income level between $50,000 and $75,000.

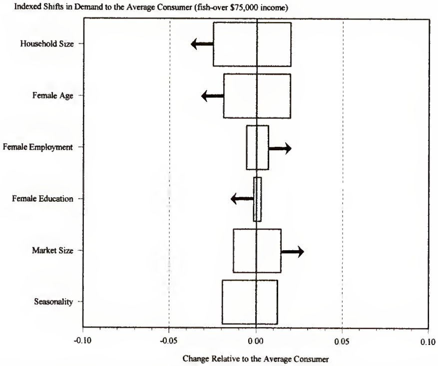

Figure 7.40: Ranking of the exogenous variables on fish demand for households with an income level over $75,000.

profiles that can be targeted by the industry when particularly strong negative effects are seen. While industries can not change demographics, they may influence purchasing behavior among these variables. For instance, if the beef industry wants to address the negative effect associated with female education levels, they should target the higher educated females. The pork industry should behave in the same way. On the other hand, the poultry industry should possibly target the lower educated households. The fish industry should try to gain market share among the families with higher numbers per household. These simulations provide this way the bases for management strategies when considering targeting specific groups of consumers based on demographics. Food industry analysts can use this information when planning marketing program strategies.

Demographics Effects (Scenario 2)

In a similar way to what was seen for the four meat products, the impact of the different demographics on the budget shares of the nine meat products will be analyzed in this section. The nine meat products are the ones previously described in Chapter 4. They include the four beef cuts (i.e., steaks, roasts, ground beef and other beef cuts) and the three poultry cuts (i.e., chicken, turkey and other poultry) together with the pork and fish. In Tables 7.2 through 7.5, are presented the shares of the nine products across different exogenous variables and for the four income groups. The shares of the four beef cuts are relatively to the total amount of beef consumed by the households, while the shares of the three poultry cuts are relatively to the total amount of poultry. In this way, it is possible to show how the mix of beef and poultry change as the category is changed.

Table 7.2: Budget Shares for the Nine Meat Products across different exogenous variables (income level under $25,000).

		Beef Share of Total Meats	Cut Share of Beef Roast	Steak	Other Beef	Ground Beef
Average consumer		39.61%	15.15%	31.56%	7.17%	46.12%
Household size(number of people)	1	39.04%	19.06%	35.75%	5.64%	39.55%
	2	39.43%	15.57%	33.12%	7.51%	43.80%
	3	39.48%	13.65%	31.15%	7.22%	47.97%
	4 plus	40.51%	12.42%	26.44%	8.24%	52.90%
Age of female (years)	29 and under	41.63%	11.63%	29.62%	5.89%	52.87%
	30 to 49	40.07%	14.75%	33.29%	6.59%	45.37%
	over 50	37.14%	19.52%	31.91%	9.21%	39.36%
Female employment level (hours)	unemployed	39.64%	15.87%	30.68%	7.62%	45.84%
	0 to 30	38.97%	15.96%	32.20%	6.16%	45.68%
	over 30	40.24%	13.64%	31.83%	7.70%	46.82%
Female education level	high school	43.61%	14.86%	29.70%	8.00%	47.44%
	college	39.72%	14.38%	28.68%	8.81%	48.14%
	post college graduate	35.50%	16.37%	37.10%	4.28%	42.25%
Census region	east	36.60%	14.26%	31.83%	6.23%	47.68%
	central	39.52%	16.30%	29.81%	5.82%	48.08%
	south	39.82%	14.69%	30.36%	7.43%	47.51%
	west	42.51%	15.24%	34.11%	8.99%	41.66%
Market size (number of people)	0 to 49,999	40.55%	16.28%	30.88%	5.89%	46.95%
	50,000 to 249,999	38.97%	13.14%	33.97%	6.39%	46.50%
	over 250,000	39.33%	15.97%	29.90%	9.26%	44.88%
Seasonality (quarters)	January-March	41.19%	16.75%	31.37%	8.45%	43.43%
	April-June	40.37%	14.29%	31.46%	7.23%	47.02%
	July-September	42.20%	13.93%	32.68%	5.88%	47.51%
	October-Dec.	34.70%	15.71%	30.61%	7.12%	46.57%

Female Age

Considering nine meat products, the categories of female age are the same ones used in the four meat products analysis. The shares of the nine meat products under the age effect and taking into account the four income levels are presented in Tables 7.2 through 7.5. Similar to the four meat

Table 7.2: Continued.

		Poultry Share of Total Meats	Cut Share of Poultry: Chicken	Turkey	Other Poultry	Pork	Fish
Average consumer		29.91%	76.26%	22.43%	1.30%	20.69%	9.79%
Household size (number of people)	1	28.73%	73.13%	25.90%	0.97%	20.46%	11.76%
	2	28.73%	73.62%	24.85%	1.53%	21.87%	9.97%
	3	30.52%	78.05%	20.81%	1.15%	21.44%	8.56%
	4 plus	31.65%	79.78%	18.67%	1.55%	18.97%	8.87%
Age of female (years)	29 and under	29.81%	79.50%	19.26%	1.24%	18.32%	10.25%
	30 to 49	30.86%	74.79%	24.01%	1.20%	19.80%	9.27%
	over 50	29.07%	74.48%	24.05%	1.48%	23.94%	9.85%
Female employment level (hours)	unemployed	31.01%	77.59%	21.25%	1.16%	20.00%	9.37%
	0 to 30	30.89%	73.00%	25.48%	1.52%	20.00%	10.14%
	over 30	27.84%	78.38%	20.40%	1.22%	22.06%	9.86%
Female education level	high school	23.61%	76.45%	22.62%	0.93%	23.62%	9.16%
	college	30.31%	73.54%	25.34%	1.12%	19.97%	9.99%
	post college graduate	35.81%	78.44%	19.85%	1.70%	18.48%	10.21%
Census region	east	31.91%	78.66%	20.40%	0.94%	19.78%	11.71%
	central	28.67%	73.91%	24.38%	1.71%	23.87%	7.95%
	south	30.83%	79.24%	19.59%	1.17%	20.39%	8.97%
	west	28.25%	72.64%	25.88%	1.49%	18.71%	10.54%
Market size (number of people)	0 to 49,999	29.88%	75.64%	22.89%	1.47%	21.33%	8.23%
	50,000 to 249,999	29.04%	76.34%	22.49%	1.17%	21.89%	10.10%
	over 250,000	30.80%	76.79%	21.94%	1.27%	18.84%	11.04%
Seasonality (quarters)	January-March	28.79%	85.38%	13.37%	1.25%	19.05%	10.98%
	April-June	28.89%	82.80%	15.78%	1.42%	20.97%	9.77%
	July-September	27.27%	83.35%	15.25%	1.39%	20.30%	10.23%
	October-Dec.	34.71%	57.65%	41.14%	1.21%	22.42%	8.18%

products scenario, as the female becomes older there is a decrease on the beef share for females with an income level under \$50,000. There are no major differences on the shares of beef under the nine products scenario in comparison with the four products scenario. Within the beef category, there is an increase in the consumption of roast and a decrease in the demand for ground beef in all income groups. In terms of household demand for steak, only in the highest income group there is an increase in demand as the female ages. The shares of poultry are also similar among the model with four

Table 7.3: Budget Shares for the Nine Meat Products across different exogenous variables (income level from $25,000 to $49,999).

		Beef Share of Total Meats	Cut Share of Beef: Roast	Steak	Other Beef	Ground Beef
Average consumer		36.85%	15.98%	35.88%	9.12%	39.02%
Household size(number of people)	1	30.15%	16.45%	48.62%	10.45%	24.48%
	2	36.88%	17.57%	36.85%	9.22%	36.36%
	3	39.92%	14.95%	33.87%	8.14%	43.04%
	4 plus	40.45%	15.15%	27.49%	9.00%	48.36%
Age of female (years)	29 and under	38.29%	11.49%	36.41%	8.33%	43.77%
	30 to 49	37.03%	15.61%	36.92%	9.29%	38.19%
	over 50	35.23%	21.23%	34.20%	9.79%	34.78%
Female employment level (hours)	unemployed	36.58%	16.89%	32.20%	8.04%	42.86%
	0 to 30	36.25%	16.52%	39.92%	9.49%	34.07%
	over 30	37.72%	14.55%	35.58%	9.78%	40.08%
Female education level	high school	40.79%	14.83%	37.31%	9.34%	38.51%
	college	37.74%	17.57%	32.59%	8.74%	41.10%
	post college graduate	32.02%	15.55%	37.91%	9.28%	37.26%
Census region	east	33.63%	15.76%	35.77%	11.89%	36.57%
	central	36.84%	15.99%	34.96%	6.30%	42.75%
	south	37.86%	15.11%	37.08%	8.24%	39.57%
	west	39.06%	16.97%	35.66%	10.24%	37.12%
Market size(number of people)	0 to 49,999	38.85%	16.91%	35.57%	8.49%	39.02%
	50,000 to 249,999	37.05%	14.98%	37.41%	7.96%	39.65%
	over 250,000	34.64%	15.99%	34.58%	11.02%	38.39%
Seasonality (quarters)	January-March	36.17%	17.14%	34.75%	9.48%	38.62%
	April-June	38.65%	14.05%	36.43%	8.67%	40.85%
	July-September	39.46%	14.62%	39.15%	8.82%	37.40%
	October-Dec.	33.12%	18.57%	32.58%	9.60%	39.25%

products compared with the nine products. Within the poultry category, a decrease in chicken and an increase in turkey consumption occurs as the female gets older in the income groups less than $75,000 a year. The effect of age in pork and fish consumption is the same as observed for the four products scenario.

Table 7.3: Continued.

		Poultry Share	Cut Share of Poultry				
		of Total Meats	Chicken	Turkey	Other Poultry	Pork	Fish
Average consumer		30.89%	78.76%	20.10%	1.13%	20.40%	11.86%
Household size(number of people)	1	33.31%	76.37%	22.13%	1.50%	21.78%	14.75%
	2	30.19%	76.85%	22.06%	1.09%	21.15%	11.79%
	3	28.91%	82.43%	16.36%	1.21%	20.15%	11.02%
	4 plus	31.16%	79.81%	19.48%	0.71%	18.50%	9.88%
Age of female (years)	29 and under	31.54%	84.50%	14.39%	1.11%	17.90%	12.27%
	30 to 49	31.19%	77.17%	21.58%	1.25%	20.54%	11.23%
	over 50	29.94%	74.42%	24.55%	1.04%	22.74%	12.08%
Female employment level (hours)	unemployed	32.89%	76.59%	22.20%	1.22%	19.10%	11.42%
	0 to 30	31.32%	79.25%	19.83%	0.93%	20.85%	11.58%
	over 30	28.45%	80.81%	17.96%	1.23%	21.24%	12.59%
Female education level	high school	25.41%	80.52%	18.58%	0.91%	22.94%	10.87%
	college	31.11%	76.44%	22.76%	0.80%	20.44%	10.70%
	post college graduate	36.15%	79.56%	18.87%	1.58%	17.81%	14.02%
Census region	east	33.66%	80.45%	18.63%	0.92%	19.58%	13.12%
	central	28.42%	78.01%	20.94%	1.06%	23.53%	11.20%
	south	30.14%	80.16%	18.61%	1.23%	20.00%	12.00%
	west	31.33%	76.35%	22.31%	1.34%	18.48%	11.13%
Market size(number of people)	0 to 49,999	29.16%	79.39%	19.86%	0.75%	21.53%	10.45%
	50,000 to 249,999	30.37%	78.27%	20.41%	1.32%	20.23%	12.34%
	over 250,000	33.13%	78.72%	19.98%	1.30%	19.43%	12.80%
Seasonality (quarters)	January-March	29.36%	86.21%	12.70%	1.09%	20.40%	14.08%
	April-June	29.87%	84.97%	13.96%	1.47%	19.70%	11.64%
	July-September	30.10%	87.74%	11.36%	0.90%	19.31%	11.13%
	October-Dec.	34.11%	59.34%	39.58%	1.08%	22.16%	10.60%

Female Employment Level

As the female goes from being unemployed to working full time, there is a decrease in the consumption of roast and an increase in the demand for steak. The consumption of ground beef is more stable, although there are some fluctuations as the level of employment changes (Tables 7.2 through 7.5). There are no major differences in the total shares of beef, when comparing the nine

Table 7.4: Budget Shares for the Nine Meat Products across different exogenous variables (income level from $50,000 to $74,999).

		Beef Share of Total Meats	Cut Share of Beef			
			Roast	Steak	Other Beef	Ground Beef
Average consumer		40.62%	14.03%	36.29%	9.60%	40.08%
Household size(number of people)	1	37.36%	9.88%	42.40%	11.08%	36.64%
	2	40.99%	16.91%	36.23%	9.42%	37.45%
	3	41.82%	14.61%	35.01%	9.49%	40.89%
	4 plus	42.31%	14.37%	32.24%	8.56%	44.84%
Age of female (years)	29 and under	41.02%	9.97%	38.49%	8.24%	43.30%
	30 to 49	40.43%	14.25%	34.97%	9.99%	40.79%
	over 50	40.43%	17.93%	35.37%	10.59%	36.06%
Female employment level (hours)	unemployed	38.89%	13.68%	34.94%	8.69%	42.68%
	0 to 30	42.46%	15.47%	37.00%	9.51%	38.01%
	over 30	40.50%	12.89%	36.84%	10.57%	39.70%
Female education level	high school	42.70%	13.37%	38.34%	9.16%	39.13%
	college	39.67%	13.99%	36.07%	10.08%	39.85%
	post college graduate	39.48%	14.79%	34.30%	9.60%	41.31%
Census region	east	37.15%	12.87%	34.94%	11.09%	41.10%
	central	41.48%	13.65%	35.75%	7.50%	43.11%
	south	40.92%	14.32%	38.93%	7.75%	39.00%
	west	42.93%	15.16%	35.48%	12.09%	37.27%
Market size(number of people)	0 to 49,999	43.25%	14.36%	33.57%	6.45%	45.62%
	50,000 to 249,999	40.43%	12.99%	38.41%	10.02%	38.58%
	over 250,000	38.16%	14.78%	37.13%	12.71%	35.38%
Seasonality (quarters)	January-March	39.85%	17.09%	34.43%	8.93%	39.55%
	April-June	42.09%	12.81%	38.11%	8.84%	40.25%
	July-September	44.61%	12.33%	38.35%	9.59%	39.72%
	October-Dec.	35.93%	14.19%	33.68%	11.24%	40.89%

products model with the four products one. Just the shares of the beef cuts slightly differ across the four income groups. For instance, the highest demand for roast occurs under the income level ranging from $25,000 to $50,000, while in the case of ground beef it occurs among households with less than $25,000 a year. Poultry consumption is also similar to what was seen under the four products

Table 7.4: Continued.

		Poultry Share	Cut Share of Poultry				
		of Total Meats	Chicken	Turkey	Other Poultry	Pork	Fish
Average consumer		26.29%	84.48%	14.26%	1.26%	19.20%	13.89%
Household size(number of people)	1	19.88%	93.46%	3.92%	2.62%	17.40%	25.36%
	2	26.75%	81.50%	17.72%	0.78%	19.57%	12.70%
	3	29.02%	84.73%	14.13%	1.14%	19.89%	9.28%
	4 plus	29.52%	80.89%	18.29%	0.81%	19.94%	8.23%
Age of female (years)	29 and under	26.48%	92.94%	6.34%	0.72%	16.89%	15.62%
	30 to 49	26.88%	84.67%	13.95%	1.38%	19.16%	13.53%
	over 50	25.52%	75.51%	22.84%	1.65%	21.56%	12.52%
Female employment level (hours)	unemployed	28.10%	84.84%	14.09%	1.07%	18.96%	14.06%
	0 to 30	26.18%	84.68%	14.29%	1.03%	18.10%	13.24%
	over 30	24.60%	83.86%	14.47%	1.67%	20.54%	14.37%
Female education level	high school	21.58%	89.34%	9.36%	1.30%	21.56%	14.16%
	college	27.90%	78.71%	19.75%	1.54%	18.65%	13.78%
	post college graduate	29.40%	86.36%	12.69%	0.95%	17.39%	13.73%
Census region	east	29.58%	85.26%	13.25%	1.49%	19.13%	14.14%
	central	24.04%	82.32%	16.72%	0.96%	22.02%	12.46%
	south	26.16%	86.70%	12.42%	0.88%	18.96%	13.97%
	west	25.39%	83.34%	15.08%	1.58%	16.67%	15.00%
Market size(number of people)	0 to 49,999	25.61%	83.29%	16.17%	0.55%	19.00%	12.14%
	50,000 to 249,999	25.29%	88.14%	9.81%	2.06%	20.35%	13.93%
	over 250,000	27.97%	82.30%	16.59%	1.11%	18.25%	15.60%
Seasonality (quarters)	January-March	25.38%	93.14%	5.79%	1.06%	17.73%	17.03%
	April-June	24.69%	94.82%	4.33%	0.85%	20.06%	13.16%
	July-September	24.19%	94.83%	4.01%	1.16%	17.88%	13.32%
	October-Dec.	30.90%	61.00%	37.25%	1.75%	21.12%	12.05%

scenario, with a decrease in the poultry demand as females go from being unemployed to working full time. Within the poultry group, the demand for chicken increases and turkey decreases as the level of employment goes up under the income groups except for the $50,000 to $75,000 a year level.

Table 7.5: Budget Shares for the Nine Meat Products across different exogenous variables (income level over $75,000).

		Beef Share of Total Meats	Cut Share of Beef: Roast	Steak	Other Beef	Ground Beef
Average consumer		35.95%	13.60%	33.13%	14.33%	38.94%
Household size(number of people)	1	32.80%	5.49%	29.21%	18.26%	47.04%
	2	34.53%	17.46%	36.32%	13.61%	32.61%
	3	38.89%	14.09%	34.35%	13.01%	38.54%
	4 plus	37.60%	16.62%	32.37%	12.93%	38.09%
Age of female (years)	29 and under	35.73%	13.10%	28.66%	15.39%	42.85%
	30 to 49	36.25%	13.16%	33.60%	14.21%	39.03%
	over 50	35.89%	14.54%	37.11%	13.37%	34.97%
Female employment level (hours)	unemployed	35.49%	15.05%	31.42%	14.51%	39.03%
	0 to 30	34.50%	13.59%	32.44%	16.06%	37.91%
	over 30	37.88%	12.25%	35.37%	12.59%	39.78%
Female education level	high school	37.44%	10.23%	38.11%	12.93%	38.73%
	college	36.59%	13.56%	31.76%	14.48%	40.20%
	post college graduate	33.85%	17.37%	29.13%	15.69%	37.81%
Census region	east	33.31%	4.43%	10.64%	5.72%	12.52%
	central	35.40%	4.85%	11.79%	4.10%	14.66%
	south	39.04%	5.29%	12.71%	5.17%	15.87%
	west	36.06%	4.98%	12.52%	5.61%	12.95%
Market size(number of people)	0 to 49,999	30.37%	17.16%	34.24%	15.51%	33.09%
	50,000 to 249,999	43.69%	10.21%	32.20%	12.73%	44.86%
	over 250,000	33.81%	14.79%	33.36%	15.32%	36.53%
Seasonality (quarters)	January-March	35.46%	15.85%	32.18%	13.17%	38.80%
	April-June	37.58%	12.56%	34.19%	13.70%	39.54%
	July-September	38.77%	12.10%	36.27%	13.28%	38.35%
	October-Dec.	32.03%	14.14%	29.16%	17.61%	39.09%

Household Size

Across household sizes, total beef and poultry shares are very similar to the ones obtained under the four products scenario. Yet even with similar total shares, the actual mix of cuts consumed

Table 7.5: Continued.

		Poultry Share of Total Meats	Cut Share of Poultry: Chicken	Cut Share of Poultry: Turkey	Cut Share of Poultry: Other Poultry	Pork	Fish
Average consumer		29.99%	72.89%	24.84%	2.27%	20.04%	14.02%
Household size(number of people)	1	26.99%	63.21%	32.60%	4.19%	25.33%	14.87%
	2	31.09%	74.27%	23.61%	2.12%	18.70%	15.68%
	3	29.72%	75.30%	22.64%	2.05%	17.30%	14.09%
	4 plus	32.12%	77.49%	21.58%	0.93%	18.81%	11.45%
Age of female (years)	29 and under	32.40%	72.28%	26.02%	1.70%	15.64%	16.21%
	30 to 49	30.81%	74.46%	23.60%	1.95%	21.03%	11.91%
	over 50	26.72%	71.86%	24.89%	3.26%	23.44%	13.96%
Female employment level (hours)	unemployed	33.31%	70.94%	28.01%	1.05%	17.91%	13.28%
	0 to 30	30.44%	73.78%	22.86%	3.35%	20.99%	14.06%
	over 30	26.17%	74.40%	23.12%	2.48%	21.22%	14.74%
Female education level	high school	25.92%	76.47%	21.14%	2.39%	22.24%	14.39%
	college	29.45%	74.97%	22.89%	2.14%	20.09%	13.88%
	post college graduate	34.57%	68.47%	29.27%	2.26%	17.79%	13.80%
Census region	east	32.61%	72.00%	25.51%	2.48%	18.72%	15.36%
	central	29.48%	71.37%	26.70%	1.93%	24.27%	10.84%
	south	27.82%	75.63%	22.39%	1.98%	18.13%	15.01%
	west	30.01%	72.84%	24.59%	2.57%	19.03%	14.89%
Market size(number of people)	0 to 49,999	33.30%	71.68%	27.09%	1.23%	22.88%	13.45%
	50,000 to 249,999	24.25%	75.38%	21.28%	3.34%	18.58%	13.48%
	over 250,000	32.39%	72.28%	25.22%	2.50%	18.65%	15.14%
Seasonality (quarters)	January-March	28.96%	79.66%	17.13%	3.21%	21.55%	14.04%
	April-June	27.50%	82.62%	15.02%	2.36%	20.14%	14.78%
	July-September	28.77%	87.31%	11.37%	1.32%	17.29%	15.17%
	October-Dec.	34.69%	47.59%	50.25%	2.16%	21.17%	12.10%

differs across household sizes. Within the beef category, as the number of members per household increases, the share of roast and steak decreases while the share of ground beef increases among lower income households. Particularly, the share of ground beef increases from 24.48 percent to 48.36 percent, within the income group from $25,000 to $50,000 a year. Within the income group ranging from $50,000 to $75,000 a year, the share of ground beef also increases, together with the roast shares. The shares of steak and the other types of beef decrease. Different results occur when looking

at the highest income group, with an increase in both shares of roast and steak and a decrease on the amount of other types of beef and ground beef demanded.

Poultry shares across the different number of members per household are very similar to the ones seen under four meat product. Within the poultry group, the highest shares of chicken are seen under the third income group (Table 7.4). In this income group and for households with one member, chicken share of total poultry expenditures reaches its highest value at 93.46 percent, while the lowest value is found under households with one person and the highest income level (Table 7.5). In the income group from \$25,000 to \$50,000, there is an increase in chicken share but an overall decrease in poultry demand going from the lowest to the highest demographic. The shares of pork and fish under the household size effect do not present major differences in comparison with the ones obtained under the four meat products.

Female Education Level

As it was already seen with the four meat products, as the female becomes more educated, there is a decrease in beef consumption and an increase in poultry consumption. Within the beef group, for households with an income level under \$25,000 a year and between \$25,000 and \$50,000 a year, there is an increase in both roast and steak share of beef and a decrease in other beef and ground beef share of all beef. Within the third income group, \$50,000 to \$75,000 a year, steak share decreases by 4 percentage points, while the share of ground beef increases by 2.18 percentage points, from 39.13 percent to 41.31 percent. The most pronounced effects of this demographic are seen under the highest income level, with an increase in the share of roast by 7.14 percentage points, from 10.23 percent to 17.37 percent and the share of steak going down by 8.98 percentage points, from 38.11 percent to 29.13 percent. Increases and decreases in the three poultry cuts demand are responsible for

the overall increase in the demand for poultry as the female becomes more educated, with the share changes remaining fairly small.

Market Size

As the market size goes from rural areas to cities with more than 250,000 people, there are fluctuations on the market shares of the different beef cuts. Particularly, within the income group ranging from \$50,000 to \$75,000 a year, market share of other types of beef increases from 6.45 percent to 12.71 percent. For the households within the same income level, the share of ground beef decreases 10.24 percentage points, from 45.62 percent to 35.38 percent across market sizes. As the market size increases, the demand for poultry products generally increases. Chicken presents the higher shares of the three poultry cuts with values over 80 percent when households are in the income group between \$50,000 and \$75,000 a year. No major differences in shares occur when looking at pork and fish in the nine product model relatively to the four product one.

Seasonality

As already seen with the four product model, the biggest changes in market shares occur in the transition during the Thanksgiving and Christmas periods. In these periods, there is an increase in the demand for poultry and a decrease in the demand for beef and fish. These results are in agreement with what was seen under the four product model. Within the poultry group, chicken share of the poultry demand drops dramatically from the third to the four quarter in all the income groups. During this same time period, there is a substantial increase in the demand for turkey. In the highest income level, the market share of chicken drops by almost 40 percentage points, 87.31 percent to

47.59 percent, going from the third to the last quarter, while the share of turkey increases from 11.37 percent to 50.25 percent.

In conclusion, faced with the results obtained for the four and nine product models, there is consistency in these 2 models. No major differences in the shares of the meat products were found using the two different AIDS models.

CHAPTER 8
SUMMARY AND CONCLUSIONS

This chapter presents a review of the major issues addressed in the preceding chapters. Several implications of the empirical results are presented, together with concluding remarks and findings associated with the objectives of the study. Having a precise empirical measure of what is driving consumers purchasing decisions is fundamental to making long term marketing and risk management decisions. Food industry analysts can use the information set forth in this research as a tool for developing marketing strategies and for gaining a better understanding of long term changes among the consumers that can impact the likelihood of each industry.

Today, the U.S. meat industry is the largest component of both the nation's agricultural sector and food marketing industry, employing nearly half a million workers and contributing over $90 billion in annual sales to the Gross National Product (GNP). Within a two-week time period 95 percent of U.S. households purchase some quantity of beef, fish, poultry or pork with annual expenditures accounting for 2.2 percent of the typical household income. This value is almost 50 percent less than 25 years ago when consumers were spending 4.3 percent of their income on meat products. Even with the percentage decline, consumer demand for meats has been increasing over the past years. Total per capita consumption of beef, poultry, pork and fish increased by 16 pounds over the past decade with the average person increasing his or her total meat consumption by more than 1.5 pounds a year since 1990 (American Meat Institute, Meat Facts). An understanding of meat demand is important to ensure that convenience and nutrition work together to satisfy household food needs. Over the last decades, there have been substantial shifts in consumption from red to white

meat. Changing lifestyles are causing consumers to demand more convenience foods. In addition this decrease in beef demand relative to pork and poultry has been partially attributed to the relative price of poultry. Numerous surveys have revealed that consumers are not only concerned with the fat and cholesterol, but are increasingly concerned with the quality and the consistency of all food products. A major management challenge for the food sector is to provide meat products consistent with these differing demands. One must have an empirical understanding of the demand for each meat type, their various cuts, and the nature of consumers' willingness to make substitutions among the types of meat. This is particularly relevant for industry participants and government policy makers, calling possibly for a quality adjustment in production and increased efforts in promotion and marketing. In order to increase market share, the meat industry must strive to create a product that meets consumers' expectations.

Meat Demand Responses

Using individual consumer household purchasing data, the impact of the major factors influencing consumers demand for competing meat products was determined. Data used in this analysis were based on household panel reports collected by the National Panel Diary Group company. Individual households reported the quantity and expenditure of each meat product consumed along with the detailed cuts within each meat type purchased in a two-week time period. The full data set from NPD included information on household demographics and the quantities and expenditures of the different households on beef, fish, poultry and pork and respective cuts. From the total household expenditures on meat products, beef accounted for the highest amount with 41.4 percent, followed by poultry with 25.0 percent, pork with 21.2 percent while fish showed the smallest

share with 12.4 percent. The different demographics include household size, age of female, female employment level, female education level, census region, and market size.

In the empirical measurement of the demand for meats, various product forms were considered where, for example, beef can be consumed as steaks, roasts, ground beef, and others and poultry may appear as chicken, turkey, or other types of poultry. Changes in these forms can be as important as the overall level of consumption of each of the four meat types. Consumers make decisions according to consumption habits, prices, and other factors with the decision directed to the meat cuts and not just the meat type such as beef. The expenditure shares (w_j) were determined showing their relationship to prices, demographics, seasonal effect, promotions, health concerns, and total expenditures. AIDS models were used to estimate the share equations.

In the AIDS model specification, demographic, promotion, and health concern variables were incorporated into the AIDS model by using translating techniques. The AIDS model was first estimated for the four meat products including beef, poultry, pork and fish, and afterwards taking into account the different beef and poultry cuts. The nine products included in the AIDS estimation were roast, steak, ground beef, other types of beef, chicken, turkey, other types of poultry, pork and fish. The data used was aggregated by household and quarter with each household entry showing the purchases of each type of meat in a quarter for a total of 37,866 observations. Maximum likelihood techniques were used in the estimation and four different income groups were considered in the estimation. This can be justified by the household consumption behavior being expected to be profoundly different across income groups. The AIDS model was estimated taking into account different scenarios. These scenarios differed in the number of meat products considered in the study, the consumption of all meat products during a particular time period and the number of times an individual household reports during the time of the survey. Scenarios one and two were the ones chosen as most appropriate for measuring the demand for meats. No significant differences in terms

of market shares were obtained using the other scenarios. A standard output from these models includes the different coefficient estimates that were divided into six categories: demographic effects, seasonality effects, health effects, promotional and advertizing effects, price effects and expenditure effects. The demographic effects included six different categories: household size, age of female, female employment level, female education level, census region and market size. The majority of the demographic effects, in both scenarios involving four or nine products were statistically significant. The seasonality effect seemed to be particularly important in the consumption of poultry across the different income groups. Health effects were seen to have an impact on both beef and pork demand. Price effects were in general statistically significant across the income groups, with higher significance across the higher incomes. Expenditure effects on meat products for the different income groups were statistically significant across the higher income groups.

Demand curves for the four meat products were determined for each income group when prices ranged from 75 percent of the mean level to 125 percent. All the demand curves were negatively sloped and relatively inelastic, except the one for fish under the highest income group. Total meat expenditures were allowed to change from 50 percent to 150 percent of the mean value for each income group. There were some changes on the market shares as expenditure levels were increased. While beef, pork and fish shares increased with meat expenditures, in the case of poultry, all the shares across the different income groups decreased. But how did the mixture of the four beef cuts and of the three poultry cuts changed as total meat expenditures went from 50 percent to 150 percent of the mean value for each income group? As expenditures on meat increase, the demand for roasts and steaks increased, while the share of ground beef decreased. The most pronounced effect of the decrease on ground beef market share is seen when households are under the income group between $25,000 and $50,000. In terms of the three poultry cuts, as meat expenditures increase, for all income groups, except the one under $25,000, there is an increase on chicken consumption. The

effect of fluctuations of price of beef on the market share of the beef cuts was evaluated by changes in mean price of beef in the range of 85 to 115 percent. With an increase in the price of beef under the lower income levels, the share of roast and steak decreases, while the share of ground beef increases. Under higher income levels, there was an increase in the share of roast, while the share of steak and ground beef decreased. With increases in the price of poultry, there is a decrease in the market share of chicken and an increase in the share of turkey and other types of poultry under the higher income groups.

The different demand elasticities were determined knowing the coefficient estimates from the AIDS models. Price, both uncompensated and compensated, expenditure and market share elasticities were computed under the four income levels. Both uncompensated and compensated own price elasticities are negative, except for fish under the highest income level. As the income level goes from under \$25,000 a year to more than \$75,000 a year, there is a decrease on the price elasticities. Cross price elasticities also decrease with higher income levels. Little substitutability was seen between fish and the other three meat products, while beef showed the highest degrees of substitutability with the other products. The expenditure elasticities showed that increases in expenditures led to increase in the demand for fish, beef and pork while the demand for poultry decreased. Small differences were seen in the expenditure elasticities across income groups.

Simulation analyses were performed to evaluate the impact of the different demographics on the household demand for meat products. The different demographics were separated from the other exogenous variables, namely the health and promotion ones in order to show what is driving the demand for each meat product. The ranking of the different demographics will help industry analysts in planning different marketing strategies. Target markets can be identified and changes can be made by the industry to try to address negative effects. Table 8.1 summarizes the different demographic

effects on the demand for the four meat types. From this table the demographics having either a positive or a negative impact on the demand for the four meat types are put into perspective.

Table 8.1: Different demographics effects on the demand for the four meat types.

Demographics	Beef	Poultry	Pork	Fish
Household Size	positive	positive except for income $25,000 / $50,000	negative except for income $50,000 / $75,000	negative
Female Age	negative except for income over $75,000	negative	positive	negative
Female Employment	positive	negative	positive	positive
Female Education	negative	positive	negative	positive except for incomes over $50,000
Market Size	negative except for income over $75,000	positive except for income over $75,000	negative	positive

Age of the female and employment level were the two demographics representative of the convenience level. Results showed that as the female gets older, there is a decrease in the demand of beef for low income households, while the demand of beef remains relatively stable across higher income groups. In the case of poultry, demand remains reasonably stable across all the income groups, except the highest one where its share decreases. Pork share increases as the female gets older, while some fluctuations are present in the demand for fish. The demand of beef, pork and fish increases as the female goes from being unemployed to working full time. Both beef and poultry demand increased with larger households while pork and fish demand declined. As the female education level increases, the demand for beef and pork decreased, while the demand for poultry

increased. The level of fish demand did not present significant variations across the different education levels. Community size also played a role in the distribution of the market shares between the different meat products. In terms of seasonality effects, poultry demand increased during Thanksgiving and Christmas periods.

Tables 8.2 through 8.5 present a ranking of the impact of the different demographics in the demand for the four meat types.

Table 8.2: Ranking of the impact of different demographics in the demand for beef.

Demographics	under $25,000	$25,000 / $50,000	$50,000 / $75,000	over $75,000
Household Size		1	1	2
Female Age	2			
Female Employment	3		3	
Female Education	1	2		3
Market Size		3	2	1

Table 8.3: Ranking of the impact of different demographics in the demand for poultry.

Demographics	under $25,000	$25,000 / $50,000	$50,000 / $75,000	over $75,000
Household Size	2	2	1	
Female Age				
Female Employment	3	3	3	3
Female Education	1	1	2	2
Market Size				1

Table 8.4: Ranking of the impact of different demographics in the demand for pork.

Demographics	under $25,000	$25,000 / $50,000	$50,000 / $75,000	over $75,000
Household Size		3	3	1
Female Age	1	1	1	2
Female Employment				
Female Education	2	2	2	3
Market Size	3			

Table 8.5: Ranking of the impact of different demographics in the demand for fish.

Demographics	under $25,000	$25,000 / $50,000	$50,000 / $75,000	over $75,000
Household Size	1	1	1	1
Female Age	3		3	2
Female Employment				
Female Education		2		
Market Size	2	3	2	3

In terms of the ranking of the different demographics, for beef and households with an income level under $25,000 a year, female education level was the demographic with the greatest impact, having a negative effect. In the income groups ranging from $25,000 to $49,999 and from $50,000 to $74,999, household size was the demographic playing the most important role with a positive effect. Market size comes in first among the high income households with an increase in beef demand in larger cities. The different demographics were also ranked in terms of their impact in

poultry consumption. In the lower income levels, female education was the demographic presenting the highest impact. But contrary to what happened under the demand for beef, as the female became more educated the demand for poultry increased. Household size remained having the highest impact when households were in the income level between $50,000 and $75,000 and market size in the highest income household level. But in this case, market size had a negative effect. The demand of poultry by households of all income levels increased during the last quarter as it could be expected by the holiday period. In terms of pork demand, for income levels under $75,000 female age is the demographic having the highest impact with an increase in the demand as the female becomes older. Household size is the most relevant variable under the highest income level. But contrary to what was seen in the demand for the other three meat products, as the number of members per household increases, the demand for pork products went down. In all the income levels, the demographic having the highest impact on fish demand is household size with the highest impact occurring when households have an income between $50,000 and $75,000 a year.

The models were finally used to compare changes within the meat groups. That is, when changes occur in the demand for the meat category (e.g., beef), how does the distribution of cuts within that group change? Similar simulations were applied to both the four and nine product models and the changes in the total share by meat type were compared. The resulting market share changes were very close between the two independent AIDS models. Then, for beef and poultry, the mix or share of that meat type was considered. When looking at the nine products, in general the demographics caused shares to shift across the four meat products, but not huge changes were seen in the mix of beef or poultry. Hence, the overall conclusion is that for beef in particular the industry can gain and lose market shares but the product mix among steaks, roasts, ground beef, and others is generally quite stable.

Broad Policy Implications

Ultimately, one must see where demand analysis, as presented in this research, can be of major use. To show that, it is first useful to have a reference for illustrating the major issues and concerns that are generally common to the meat industry. Figure 8.1 can be used to provide that reference for discussion. As presented through this dissertation, the meat sector was defined to include the four meats products and modeled using the AIDS framework. These products are interrelated as suggested with the connecting lines in the figure. Outside of the major box are identified several issues that would be considered exogenous to the meat industry, but have a major impact on the overall performance of each meat sector. Changing demographics, distribution of wealth, health concerns, changing preferences, and perceptions (information) all relate to the consumer and have been extensively discussed in this research. While the meat sectors may not have the capability to change these factors, they clearly must understand the consequences of the various changes. Product innovation, structural change and technological change often set the direction for most supply chains including the meat sector. Often product attributes change and they are difficult to measure with existing data sets. For example, the labeling of a product is usually not revealed in the purchasing data such as the one used in this research. While the demand analysis as presented with the AIDS model is extremely useful, one must still recognize the limits in that these models do not always directly capture such technological changes and innovations. Clearly, that is a weakness of the analysis. However, within the box of exogenous factors, one cannot expect to draw generalities or conclusions without first having a good insight into the fundamental nature of the demand for the products, while recognizing the modeling limits. This dissertation provides a detailed analysis of the nature of demand for each of the four meats. In some situations such as dealing with regulatory and trade policies, a knowledge of demand elasticities and cross elasticities is the first step in dealing with

both type of policy issues. One can turn to the elasticity tables and the subsequent simulations to gain empirical insight into demand. Furthermore, while not part of this dissertation, the same models can be simulated under different conditions that might relate to a specific trade or regulatory policy. For example one could take the models and impose say a 20 percent reduction in beef demand because of a health scare and simulate the overall impact on the meat sector. Another example would be to simulate an overall decline in economic growth, relate that to meat expenditures and then show its impact on each meat sector. These are a few of many examples that could be cited.

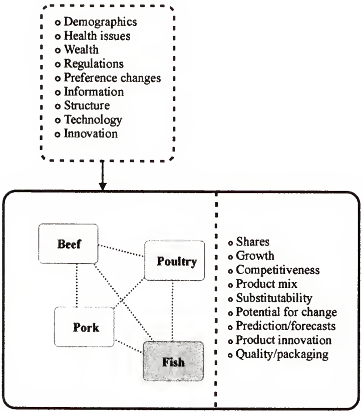

Figure 8.1: Meat industry issues in perspective.

Next within the meat sector box several issues have been identified that are most specific to each sector. Most of these have been dealt in some way within the simulations while recognizing that one cannot be specific until an exact issue is raised. For example, the simulation section included changes in total meat expenditures and set forth the expected total growth and shift in shares among beef, pork, poultry, and fish. A more specific approach would have been to assume that over the next several years expenditures are expected to grow at say 3 percent per year. It is reasonably straight-forward to simulate the share and growth changes in demand that would be expected. The AIDS models presented here are particularly useful for showing the impacts of wealth (expenditures), demographics, relative pricing, information, and health concerns. The dissertation concentrated on the wealth, demographics and pricing while not giving the same weight to the other factors. Those other factors will be considered in later research.

It is beyond the scope of the current research efforts to address every useful policy consideration where the demand analysis has a role. At this point, however, it is essential to recognize the linkage among the meat sectors and the issues (Figure 8.1) and the role that demand analysis plays. With the empirical measures of demand, competitiveness among the four meats can be shown. For example, if major technological changes reduced the cost of producing beef and hence the relative prices to poultry, pork and fish, then these models are of immediate use for showing the expected change among the sectors. How much of a change in beef demand could be expected when investing in efficiency type efforts that reduce the price spread between beef and the other meats? The AIDS model as presented here can directly be used to simulate the expected share changes.

Probably the most fundamental role of the models relates to understanding what is causing the demands to change and by how much. The role of demographics is most clear and can be addressed in many different ways. For example, one could ask what would be expected by the year say 2010 if all conditions remained fixed except for aging. What would each sector look like if

nothing is done about the impact of aging? The extent of the change would both show the magnitude of the impact and whether or not it is important enough to focus on. Similarly, maybe the answer to change is in the relative prices not worrying about the demographic effects. The models would be used to show how much of a relative price change in the beef sector would be required to offset the effects of aging or some other demographic. Is that change reasonable or unreasonable? Other studies have shown promotions to be effective but small in its total impact. Assuming that promotions at best cause a two or three percent growth in demand, is that enough to offset those negative demographic effects? If not, a more concentrated promotion effort is needed. In essence, these models are particularly useful for simulation comparisons of offsetting (or partially offsetting) effects and to gain an understanding if whether it is even reasonable to try to correct the impacts of certain demographics. Equally useful are the scenarios labeled as the "do nothing" approach. What would these industries look like in five or ten years without corrective actions. Demand models as presented are absolutely the cornerstone for addressing the "do nothing" type policies. Why the modeling may not provide the best predictions, the direction and relative changes are what is important. In this final section it is recognized that specific policies have not been considered as was the intent of the analysis. Yet it is equally recognized that demand analysis such as presented in this research must be in place for the meat sectors to be proactive in dealing with the livelihood of their industries.

Considerations for Further Research

This study provides useful information for discussion about the factors influencing the demand for meat products and the different cuts. This research could benefit by including other types of food products as another product. Knowing the percentage of consumers income that is spent on

food products and the income of each of the households involved in this study, it is possible to perform the analysis done in this study. An AIDS model could be estimated for five products, including the four meat products and the other food products. This expansion of the model is to be considered in further research.

During this dissertation, little focus was placed on health and promotion effects due to the limited time period that this analysis was based on (last quarter of 1992 through first quarter of 1998). Much of the health and promotion effects are extended over a longer time frame, hence making it more difficult to adequately capture the variation in these variables. While variations are seen in the data in terms of household demographics, less variation was seen in terms of health and promotion during the same time period in comparison to the years since the early 80's. As was previously mentioned this can be justified by the short period of time that runs from 1992 to 1998. In addition, promotions can not be separated by individuals. Another study done by (Ward, 1999), using a beef servings data set ranging from 1984 through 1997, showed a positive effect on demand by promotions. Plans are to pursue these two impacts in additional research after the completion of this phase of the demand analysis. The extended model results will also be compared to the ones obtained in this study.

APPENDIX A
TSP PROGRAM (AIDS MODEL)

```
OPTIONS MEMORY=500 LIMWNUMC=0;
TITLE 'QUARTERLY AIDS MODEL BY FOUR INCOME GROUP & ZDDDMEATZ=1 -
Medina and Ward';

? aidsQTR#02.tsp;
? PPER     Q55801  Q55703   SHE557   HWDDIST ;
? FAMC     E55801  E55703   SFE557   QTR     ;
? ZTYPEZ   Q55901  Q55704   SHQ558   YEAR    ;
? ZFREQZ   E55901  E55704   SFQ558   MAXREP  ;
? MNDINC   Q55902  Q557TOT  SHE558   MHLTLNA ;
? MNDHSZ   E55902  Q558TOT  SFE558   PRCHL   ;
? MNDAGF   Q55903  Q559TOT  SHQ559   PRFAT   ;
? MNDCHD   E55903  Q560TOT  SFQ559   PROM    ;
? MNDEMF   Q55904  E557TOT  SHE559   ADVR    ;
? MNDEDF   E55904  E558TOT  SFE559   LNA#BF  ;
? MNDEDM   Q56001  E559TOT  SHQ560   LNA#PK  ;
? MNDSTA   E56001  E560TOT  SFQ560   LNA#PL  ;
? MNDADI   Q55701  QTOT     SHE560   LNA#TK  ;
? MNDMSA   E55701  ETOT     SFE560           ;
? MNDAGM   Q55702  SHQ557   IDENT            ;
? MNDOCP   E55702  SFQ557   FAMCNUM          ;
? 557=beef  558=fish 559=poultry 560=pork    ;
? IDD=number of times reporting each quarter;

in  'D:\ZBEEF\ZMEATDMD\DATABASE\FAMCM_QTR';

?===============================================;
? GO TO STEP (10) FOR THE ESTIMATION            ;
?===============================================;
?===============================================;
? LET BEEF= 1  POULTRY= 2 PORK= 3 AND FISH= 4   ;
? QT=QUANTITY EX=EXPENDITURES PR=PRICE W=SHARE  ;
?===============================================;

LIST DATA02 Q55801  Q55703 E55801  E55703 Q55901  Q55704
E55901  E55704 Q55902  Q557TOT E55902  Q558TOT Q55903  Q559TOT
E55903  Q560TOT Q55904  E557TOT E55904  E558TOT Q56001  E559TOT
E56001  E560TOT Q55701  QTOT   E55701  ETOT   Q55702  E55702;

? STEP (1A): CORRECTING QUANTITIES & EXPENDITURES FOR REPORTING
```

```
TIMES;
?=====================================================================
===========;
? DIVIDE QXXXYY AND EXXXYY BY IDD TO PUT ON AVERAGE PER PURCHASING
OCCASSION;
?=====================================================================
===========;
 DOT DATA02;  .=./IDD; ENDDOT;

? STEP (1B);
?==============================================;
? CALCULATING EXPENDITURES;
? NOTE THAT EXPENDITURES CAN BE ZERO;
? DEFINING THE EXOGENEOUS VARIABLES;
?==============================================;

? STEP (4) AND (9) MUST BE ADJUSTED DEPENDING ON THE NUMBER OF
VARIALBES;

? STEP (1C);
?==============================================;
? CALCULATING EXPENDITURES;
? NOTE THAT EXPENDITURES CAN BE ZERO;
? DEFINING THE EXOGENEOUS VARIABLES;
?==============================================;
? CONTROLLING ON ABSENCE OF DEMOGRAPHIC INFORMATION;
DDDEMO=(MNDINC>0) & (MNDHSZ>0) & (MNDAGF>0) &  (MNDCHD>0) &
(MNDEMF>0) &  (MNDEDF>0) &  (MNDSTA>0) &  (MNDADI>0) &  (MNDMSA >0)
;
HIST(DISCRETE) DDDEMO;

? CONTROLLING OF IF CONSUMING ALL MEATS AT THE SAME PERIOD;
DDDMEAT=(E557TOT>0) & (E558TOT>0) & (E559TOT>0) & (E560TOT>0);
HIST(DISCRETE) DDDMEAT;

SELECT DDDEMO=1;

? HOUSEHOLD INCOME RANGES;
DINC=(MNDINC<=13) + ((MNDINC>=15) & (MNDINC<=19))*2 +
((MNDINC>=20) & (MNDINC<=24))*3 + (MNDINC>=25)*4;
DUMMY DINC;
HIST(DISCRETE,PERCENT) DINC;
VAR1= DINC1 - DINC4;
VAR2= DINC2 - DINC4;
VAR3= DINC3 - DINC4;

? HOUSEHOLD SIZE;
DHSZ=(MNDHSZ=1)*1 + (MNDHSZ=2)*2 + (MNDHSZ=3)*3 + (MNDHSZ>=4)*4;
DUMMY DHSZ;
HIST(DISCRETE,PERCENT) DHSZ;
VAR4=DHSZ1 - DHSZ4;
```

```
VAR5=DHSZ2 - DHSZ4;
VAR6=DHSZ3 - DHSZ4;

? AGE OF FEMALE HEAD OF HOUSEHOLD;
DAGF=( (MNDAGF>0) & (MNDAGF<=2))*1 + ((MNDAGF>=3) & (MNDAGF<=6))*2
+ (MNDAGF>=7)*3;
DUMMY DAGF;
HIST(DISCRETE,PERCENT) DAGF;
VAR7=DAGF1 - DAGF3;
VAR8=DAGF2 - DAGF3;

? CHILDREN UNDER 18 IN HOUSEHOLD;
DCHD=(MNDCHD<=7);
DUMMY DCHD;
HIST(DISCRETE,PERCENT) DCHD;
VAR9=DCHD1 - DCHD2;

? FEMALE EMPLOYMENT STATUS;
DEMF=((MNDEMF=9) )*1 + (MNDEMF=1)*2 + ( (MNDEMF>1) & (MNDEMF<9))*
3;
DUMMY DEMF;
VAR10=DEMF1-DEMF3;
VAR11=DEMF2-DEMF3;

? FEMALE EDUCATION;
DEDF=( (MNDEDF>0) & (MNDEDF<=3)) + ( (MNDEDF>=4) & (MNDEDF<=5))*2
+ (MNDEDF=6)*3;
DUMMY DEDF;
HIST(DISCRETE,PERCENT) DEDF;
VAR12=DEDF1-DEDF3;
VAR13=DEDF2-DEDF3;


DSTA=(MNDSTA<30)*1 + ((MNDSTA>=30) & (MNDSTA<50))*2 +
((MNDSTA>=50) & (MNDSTA<80))*3 + (MNDSTA>=80)*4;
DUMMY DSTA;
HIST(DISCRETE,PERCENT) DSTA;
VAR14=DSTA1-DSTA4;
VAR15=DSTA2-DSTA4;
VAR16=DSTA3-DSTA4;


? MARKET SIZE;
DMSA=(MNDMSA=9)*1 + (MNDMSA=1)*2 + ((MNDMSA>=3) & (MNDMSA<=8))*3;
DUMMY DMSA;
HIST(DISCRETE,PERCENT) DMSA;
VAR17=DMSA1-DMSA3;
VAR18=DMSA2-DMSA3;

VAR19=PRCHL;
VAR20=SQRT(PROM);
```

```
VAR21=SQRT(LNA#PK);
VAR22=SQRT(LNA#PL + LNA#TK);

? SEASONALITY;
DUMMY QTR;
VAR23=QTR1-QTR4;
VAR24=QTR2-QTR4;
VAR25=QTR3-QTR4;

SELECT 1;

EX1=E557TOT;  ? EXPENDITURES ON BEEF;
EX2=E559TOT;  ? EXPENDITURES ON POULTRY;
EX3=E560TOT;  ? EXPENDITURES ON PORK;
EX4=E558TOT;  ? EXPENDITURES ON FISH;
EX = EX1 + EX2 + EX3 + EX4; ? TOTAL EXPENDITURES;
SELECT EX>0;
LEX=LOG(EX);
SELECT 1;
QT1=Q557TOT;  ? QUANTITY ON BEEF;
QT2=Q559TOT;  ? QUANTITY ON POULTRY;
QT3=Q560TOT;  ? QUANTITY ON PORK;
QT4=Q558TOT;  ? QUANTITY ON FISH;
QT=QT1 + QT2 + QT3 + QT4;   ? TOTAL QUANTITY;
SELECT QT>0;
LQT=LOG(QT);
SELECT 1;
DOT 1 2 3 4;  ? CREATING EXPENDITURE SHARES;
W. = EX./( (EX>0)*EX + (EX=0) ); ENDDOT;

DELETE E557TOT E559TOT E560TOT E558TOT Q557TOT Q559TOT Q560TOT
Q558TOT
DINC1-DINC4 DHSZ1-DHSZ4 DAGF1-DAGF3 DCHD1-DCHD2
DEMF1-DEMF3 DEDF1-DEDF3 DSTA1-DSTA4
DHSZ DAGF DCHD DEMF DEDF DSTA
PRCHL PROM LNA#PK LNA#PL LNA#TK;
COMPRESS;


? STEP (2);
?===========================================;
? CREATING AN AVERAGE PRICE FOR EACH MEAT BY    ;
? YEAR AND MONTH                                ;
? IF THE EXPENDITURES ARE ZERO THEN WE WILL USE ;
? THE AVERAGE PRICE IN THE MODEL                ;
?===========================================;
DO ZYR=1992 TO 1998;
DO ZQTRZ=3 TO 12 BY 3;
SELECT ( (YEAR=ZYR) & (QTR=ZQTRZ) );
IF @NOB=0; THEN; GOTO 100;
MSD(NOPRINT) EX1 EX2 EX3 EX4 QT1 QT2 QT3 QT4;
```

```
APR1=@SUM(1)/@SUM(5);  ? AVERAGE PRICE FOR BEEF;
APR2=@SUM(2)/@SUM(6);  ? AVERAGE PRICE FOR POULTRY;
APR3=@SUM(3)/@SUM(7);  ? AVERAGE PRICE FOR PORK;
APR4=@SUM(4)/@SUM(8);  ? AVERAGE PRICE FOR FISH;
DOT 1 2 3 4;
PR.=( EX. / ((EX.>0)*QT. + (EX.=0)) ) + (EX.= 0)*APR.;
LPR.=LOG(PR.); ENDDOT;        ? LOG OF PRICES;
100 ENDDO; ENDDO;
SELECT 1;


? STEP (3);
?==============================================;
? ADDING UP CONDITION FOR FOUR EQUATIONS        ;
?==============================================;
FRML ZAD1 A4=(1-A1-A2-A3); ? SUM OF A'S =1;
FRML ZBD1 B4=(-B1-B2-B3);  ? SUM OF B'S =0;

? HOMOGENEITY CONDITIONS WITH SYMMETRY IMPOSED;
? FRML ZGG11 AG41=(-AG11-AG21-AG31);
  FRML ZGG11 AG14=(-AG11-AG12-AG13);

? FRML ZGG12 AG42=(-AG12-AG22-AG32);
  FRML ZGG12 AG24=(-AG12-AG22-AG23);

? FRML ZGG13 AG43=(-AG13-AG23-AG33);
  FRML ZGG13 AG34=(-AG13-AG23-AG33);

? FRML ZGG14 AG44=(-AG14-AG24-AG34);
  FRML ZGG14 AG44=(-AG14-AG24-AG34);
  EQSUB ZGG14 ZGG11 ZGG12 ZGG13;

? SYMMETRY CONDITIONS - NO LONGER NEEDED SINCE IT IS IN THE
QUESTIONS;
? FRML ZSYM14 AG41=AG14;
? FRML ZSYM13 AG31=AG13;
? FRML ZSYM12 AG21=AG12;
? FRML ZSYM23 AG32=AG23;
? FRML ZSYM24 AG42=AG24;
? FRML ZSYM34 AG43=AG34;

? SYMMETRY SUBSTITUTION TO THE HOMOGENEITY CONDITIONS;
? ABOVE HAVE IMPOSED THE SYMMETRY DIRECTLY INTO THE EQUATION;
? EQSUB ZGG11 ZSYM14 ZSYM13 ZSYM12 ZSYM23 ZSYM24 ZSYM34;
? EQSUB ZGG12 ZSYM14 ZSYM13 ZSYM12 ZSYM23 ZSYM24 ZSYM34;
? EQSUB ZGG13 ZSYM14 ZSYM13 ZSYM12 ZSYM23 ZSYM24 ZSYM34;
? EQSUB ZGG14 ZSYM14 ZSYM13 ZSYM12 ZSYM23 ZSYM24 ZSYM34;


  FRML ZG11 AG11*LPR1 + AG12*LPR2 + AG13*LPR3 + AG14*LPR4;
```

```
? FRML ZG12 AG21*LPR1 + AG22*LPR2 + AG23*LPR3 + AG24*LPR4;
  FRML ZG12 AG12*LPR1 + AG22*LPR2 + AG23*LPR3 + AG24*LPR4;

? FRML ZG13 AG31*LPR1 + AG32*LPR2 + AG33*LPR3 + AG34*LPR4;
  FRML ZG13 AG13*LPR1 + AG23*LPR2 + AG33*LPR3 + AG34*LPR4;

? FRML ZG14 AG41*LPR1 + AG42*LPR2 + AG43*LPR3 + AG44*LPR4;
  FRML ZG14 AG14*LPR1 + AG24*LPR2 + AG34*LPR3 + AG44*LPR4;

? SUBSTITUTING HOMOGENEITY INTO SYMMETRY CONDITIONS
EQSUB ZG11 ZGG11 ZGG12 ZGG13 ZGG14; ? ZSYM14 ZSYM13 ZSYM12 ZSYM23
ZSYM24 ZSYM34;
EQSUB ZG12 ZGG11 ZGG12 ZGG13 ZGG14; ? ZSYM14 ZSYM13 ZSYM12 ZSYM23
ZSYM24 ZSYM34;
EQSUB ZG13 ZGG11 ZGG12 ZGG13 ZGG14; ? ZSYM14 ZSYM13 ZSYM12 ZSYM23
ZSYM24 ZSYM34;
EQSUB ZG14 ZGG11 ZGG12 ZGG13 ZGG14; ? ZSYM14 ZSYM13 ZSYM12 ZSYM23
ZSYM24 ZSYM34;


? STEP (4);
?=====================================================;
? ADDING EXOGENOUS VARIABLES TO THE MODEL             ;
? EXAMPLE FOR 5 EXOGENEOUS VARIALBS                   ;
? NUMBER OF CHILDREN REMOVED FROM ESTIMATES           ;
?=====================================================;
FRML ZXG1 K104*VAR4 + K105*VAR5 + K106*VAR6 +
K107*VAR7 + K108*VAR8 + 0*VAR9 + K110*VAR10 + K111*VAR11 +
K112*VAR12 +
K113*VAR13 + K114*VAR14 + K115*VAR15 + K116*VAR16 + K117*VAR17 +
K118*VAR18 +
K119*VAR19 + K120*VAR20 + K121*VAR21 + K122*VAR22 +
K123*VAR23 + K124*VAR24 + K125*VAR25 ;

FRML ZXG2 K204*VAR4 + K205*VAR5 + K206*VAR6 +
K207*VAR7 + K208*VAR8 + 0*VAR9 + K210*VAR10 + K211*VAR11 +
K212*VAR12 +
K213*VAR13 + K214*VAR14 + K215*VAR15 + K216*VAR16 + K217*VAR17 +
K218*VAR18 +
K219*VAR19 + K220*VAR20 + K221*VAR21 + K222*VAR22 +
K223*VAR23 + K224*VAR24 + K225*VAR25 ;

FRML ZXG3 K304*VAR4 + K305*VAR5 + K306*VAR6 +
K307*VAR7 + K308*VAR8 + 0*VAR9 + K310*VAR10 + K311*VAR11 +
K312*VAR12 +
K313*VAR13 + K314*VAR14 + K315*VAR15 + K316*VAR16 + K317*VAR17 +
K318*VAR18 +
K319*VAR19 + K320*VAR20 + K321*VAR21 + K322*VAR22 +
K323*VAR23 + K324*VAR24 + K325*VAR25 ;

FRML ZXG4 K404*VAR4 + K405*VAR5 + K406*VAR6 +
```

```
K407*VAR7  +  K408*VAR8  +  0*VAR9  +  K410*VAR10  +  K411*VAR11  +
K412*VAR12 +
K413*VAR13 + K414*VAR14 + K415*VAR15 + K416*VAR16 + K417*VAR17 +
K418*VAR18 +
K419*VAR19 + K420*VAR20 + K421*VAR21 + K422*VAR22 +
K423*VAR23 + K424*VAR24 + K425*VAR25;


FRML ZK4 K404=-K104-K204-K304;
FRML ZK5 K405=-K105-K205-K305;
FRML ZK6 K406=-K106-K206-K306;
FRML ZK7 K407=-K107-K207-K307;
FRML ZK8 K408=-K108-K208-K308;
FRML ZK10 K410=-K110-K210-K310;
FRML ZK11 K411=-K111-K211-K311;
FRML ZK12 K412=-K112-K212-K312;
FRML ZK13 K413=-K113-K213-K313;
FRML ZK14 K414=-K114-K214-K314;
FRML ZK15 K415=-K115-K215-K315;
FRML ZK16 K416=-K116-K216-K316;
FRML ZK17 K417=-K117-K217-K317;
FRML ZK18 K418=-K118-K218-K318;
FRML ZK19 K419=-K119-K219-K319;
FRML ZK20 K420=-K120-K220-K320;
FRML ZK21 K421=-K121-K221-K321;
FRML ZK22 K422=-K122-K222-K322;
FRML ZK23 K423=-K123-K223-K323;
FRML ZK24 K424=-K124-K224-K324;
FRML ZK25 K425=-K125-K225-K325;
? FRML ZK9 K409=-K109-K209-K309; ? REMOVING CHILDREN FROM THE MODEL;


EQSUB ZXG1 ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13
ZK14 ZK15 ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25 ;

EQSUB ZXG2 ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13
ZK14 ZK15 ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25 ;

EQSUB ZXG3 ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13
ZK14 ZK15 ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25 ;

EQSUB ZXG4 ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13
ZK14 ZK15 ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25 ;


? STEP (5);
?=====================================================;
? CREATING THE P EQUATIONS                      ;
?=====================================================;
FRML PPR1 ((A1+ ZXG1 )+(1/2)*(ZG11))*LPR1;
```

```
EQSUB PPR1 ZAD1 ZG11 ZXG1;

FRML PPR2 ((A2+ ZXG2 )+(1/2)*(ZG12))*LPR2;
EQSUB PPR2 ZAD1 ZG12 ZXG2;

FRML PPR3 ((A3+ ZXG3 )+(1/2)*(ZG13))*LPR3;
EQSUB PPR3 ZAD1 ZG13 ZXG3;

FRML PPR4 ((A4+ ZXG4 )+(1/2)*(ZG14))*LPR4;
EQSUB PPR4 ZAD1 ZG14 ZXG4;

? AVERAGE PRICE
FRML APPR PPR1 + PPR2 + PPR3 + PPR4;
EQSUB APPR PPR1 PPR2 PPR3 PPR4;


? STEP (6);
?=======================================================;
? CREATING STONE INDEX = SPPR                           ;
?=======================================================;
FRML SPPR W1*LPR1 + W2*LPR2 + W3*LPR3 + W4*LPR4;


? STEP (7);
?=======================================================;
? EXPENDITURE EQUATIONS
?=======================================================;
FRML EQ1 W1=A1 + ZXG1 + ZG11 + B1*(LEX-APPR);
EQSUB EQ1 ZAD1 ZBD1 ZG11 APPR ZXG1;

FRML EQ2 W2=A2 + ZXG2 + ZG12 + B2*(LEX-APPR);
EQSUB EQ2 ZAD1 ZBD1 ZG12 APPR ZXG2;

FRML EQ3 W3=A3 + ZXG3 + ZG13 + B3*(LEX-APPR);
EQSUB EQ3 ZAD1 ZBD1 ZG13 APPR ZXG3;

FRML EQ4 W4=A4 + ZXG4 + ZG14 + B4*(LEX-APPR);
EQSUB EQ4 ZAD1 ZBD1 ZG14 APPR ZXG4;


COMPRESS;
? STEP (8);
?=======================================================;
? EXPENDITURE EQUATIONS USING THE STONE INDEX
?=======================================================;
FRML SQ1 W1=A1 + ZXG1 + ZG11 + B1*(LEX-SPPR);
EQSUB SQ1 ZAD1 ZBD1 ZG11 SPPR ZXG1;

FRML SQ2 W2=A2 + ZXG2 + ZG12 + B2*(LEX-SPPR);
EQSUB SQ2 ZAD1 ZBD1 ZG12 SPPR ZXG2;
```

```
FRML SQ3 W3=A3 + ZXG3 + ZG13 + B3*(LEX-SPPR);
EQSUB SQ3 ZAD1 ZBD1 ZG13 SPPR ZXG3;

FRML SQ4 W4=A4 + ZXG4 + ZG14 + B4*(LEX-SPPR);
EQSUB SQ4 ZAD1 ZBD1 ZG14 SPPR ZXG4;


? STEP (9);
?=====================================================;
? ADJUST ACCORDING TO THE NUMBER OF EXOGENEOUS VARIABLES ;
?=====================================================;
PARAM A1 A2 A3 A4 B1 B2 B3 B4
      AG11 AG12 AG13 AG14 AG22 AG23 AG24 AG33 AG34 AG44
      K104 K105 K106 K107 K108 K110 K111 K112
       K113 K114 K115 K116 K117 K118 K119 K120 K121 K122 K123 K124
K125
      K204 K205 K206 K207 K208 K210 K211 K212
       K213 K214 K215 K216 K217 K218 K219 K220 K221 K222 K223 K224
K225
      K304 K305 K306 K307 K308 K310 K311 K312
       K313 K314 K315 K316 K317 K318 K319 K320 K321 K322 K323 K324
K325
      K404 K405 K406 K407 K408 K410 K411 K412
       K413 K414 K415 K416 K417 K418 K419 K420 K421 K422 K423 K424
K425 ;

? ORIGINAL PARAMETERS WITHOUT SYMMETRY;
? AG11 AG12 AG13 AG14 AG21 AG22 AG23 AG24
? AG31 AG32 AG33 AG34 AG41 AG42 AG43 AG44



? STEP (10);
?=================================================;
? NONLINEAR ESTIMATION WITH BOTH MODELS BY INCOME GROUP;
?=================================================;


SET ZDDDMEATZ=0; ? CONTROLLING IF CONSUMING ALL MEATS=1 ;
SET UPPER=50;    ? REMOVING POTENTIAL OUTLIERS IN TERMS OF POUNDS;
DUPPER=(QT1<=UPPER) & (QT2<=UPPER) & (QT3<=UPPER) & (QT4<=UPPER);
HIST(DISCRETE) DUPPER;


SET ZDINCZ=1;    ? CONTROLLING ON INCOME - UNDER $25,000;
SELECT (EX>0) & (YEAR<=1997) & (DDDEMO=1) & (DDDMEAT>=ZDDDMEATZ)
&(DINC=ZDINCZ) & (DUPPER=1);
? WITH CORRECTION FOR HETEROSCEDASTICITY INCOME GROUP ;
PRINT ZDINCZ;
LSQ (MAXIT=100,HETERO) EQ1 EQ2 EQ3;
PRINT @COEF;
```

```
ANALYZ ZAD1 ZBD1 ZGG11 ZGG12 ZGG13 ZGG14
ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13 ZK14 ZK15
ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25;
? GIVING THE RESULTS FOR THE EQUATION NOT ESTIMATED;
PRINT @COEFA @SESA @TA;
DOT 1;
MMAKE(VERT) BETASINC. @COEF @COEFA;
MMAKE(VERT) TTESTINC. @T @TA; ENDDOT;

SET ZDINCZ=2;     ? CONTROLLING ON INCOME - $25,000 - $50,000;
SELECT (EX>0) & (YEAR<=1997) & (DDDEMO=1) & (DDDMEAT>=ZDDDMEATZ)
&(DINC=ZDINCZ) & (DUPPER=1);
? WITH CORRECTION FOR HETEROSCEDASTICITY INCOME GROUP ;
PRINT ZDINCZ;
LSQ (MAXIT=100,HETERO) EQ1 EQ2 EQ3;
PRINT @COEF;
ANALYZ ZAD1 ZBD1 ZGG11 ZGG12 ZGG13 ZGG14
ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13 ZK14 ZK15
ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25;
PRINT @COEFA @SESA @TA;
DOT 2;
MMAKE(VERT) BETASINC. @COEF @COEFA;
MMAKE(VERT) TTESTINC. @T @TA; ENDDOT;


SET ZDINCZ=3;     ? CONTROLLING ON INCOME - $50,000-$75,000;
SELECT (EX>0) & (YEAR<=1997) & (DDDEMO=1) & (DDDMEAT>=ZDDDMEATZ)
&(DINC=ZDINCZ) & (DUPPER=1);
? WITH CORRECTION FOR HETEROSCEDASTICITY INCOME GROUP ;
PRINT ZDINCZ;
LSQ (MAXIT=100,HETERO) EQ1 EQ2 EQ3;
PRINT @COEF;
ANALYZ ZAD1 ZBD1 ZGG11 ZGG12 ZGG13 ZGG14
ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13 ZK14 ZK15
ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25;
PRINT @COEFA @SESA @TA;
DOT 3;
MMAKE(VERT) BETASINC. @COEF @COEFA;
MMAKE(VERT) TTESTINC. @T @TA; ENDDOT;


SET ZDINCZ=4;     ? CONTROLLING ON INCOME - OVER $75,000;
SELECT (EX>0) & (YEAR<=1997) & (DDDEMO=1) & (DDDMEAT>=ZDDDMEATZ)
&(DINC=ZDINCZ) & (DUPPER=1);
? WITH CORRECTION FOR HETEROSCEDASTICITY INCOME GROUP ;
PRINT ZDINCZ;
LSQ (MAXIT=100,HETERO) EQ1 EQ2 EQ3;
PRINT @COEF;
ANALYZ ZAD1 ZBD1 ZGG11 ZGG12 ZGG13 ZGG14
ZK4 ZK5 ZK6 ZK7 ZK8 ZK10 ZK11 ZK12 ZK13 ZK14 ZK15
```

```
ZK16 ZK17 ZK18 ZK19 ZK20 ZK21 ZK22 ZK23 ZK24 ZK25;
PRINT @COEFA @SESA @TA;
DOT 4;
MMAKE(VERT) BETASINC. @COEF @COEFA;
MMAKE(VERT) TTESTINC. @T @TA; ENDDOT;

? PRINT @RNMS @RNMSA;
MMAKE AIDSINC01 BETASINC1 TTESTINC1 BETASINC2 TTESTINC2 BETASINC3
TTESTINC3 BETASINC4 TTESTINC4;
WRITE(FORMAT=LOTUS,FILE='C:\ZBEEF\ZMEATDMD\AIDSTSP\AIDS01.WK1')
AIDSINC01;
END;
```

APPENDIX B
TSP PROGRAM (SIMULATIONS)

```
OPTIONS MEMORY=500 LIMWNUMC=0;
TITLE 'QUARTERLY AIDS MODEL BY FOUR INCOME GROUP & ZDDDMEATZ=1 -
Medina and Ward';

? aidsQTR#02.tsp;
? PPER     Q55801  Q55703   SHE557   HWDDIST ;
? FAMC     E55801  E55703   SFE557   QTR     ;
? ZTYPEZ   Q55901  Q55704   SHQ558   YEAR    ;
? ZFREQZ   E55901  E55704   SFQ558   MAXREP  ;
? MNDINC   Q55902  Q557TOT  SHE558   MHLTLNA ;
? MNDHSZ   E55902  Q558TOT  SFE558   PRCHL   ;
? MNDAGF   Q55903  Q559TOT  SHQ559   PRFAT   ;
? MNDCHD   E55903  Q560TOT  SFQ559   PROM    ;
? MNDEMF   Q55904  E557TOT  SHE559   ADVR    ;
? MNDEDF   E55904  E558TOT  SFE559   LNA#BF  ;
? MNDEDM   Q56001  E559TOT  SHQ560   LNA#PK  ;
? MNDSTA   E56001  E560TOT  SFQ560   LNA#PL  ;
? MNDADI   Q55701  QTOT     SHE560   LNA#TK  ;
? MNDMSA   E55701  ETOT     SFE560           ;
? MNDAGM   Q55702  SHQ557   IDENT            ;
? MNDOCP   E55702  SFQ557   FAMCNUM          ;
? 557=beef  558=fish 559=poultry 560=pork    ;
? IDD=number of times reporting each quarter;

in  'D:\ZBEEF\ZMEATDMD\DATABASE\FAMCM_QTR';
SET NOB=@NOB;
PRINT NOB;


?==============================================;
? GO TO STEP (10) FOR THE ESTIMATION           ;
?==============================================;



?==============================================;
? LET BEEF= 1  POULTRY= 2 PORK= 3 AND FISH= 4   ;
? QT=QUANTITY EX=EXPENDITURES PR=PRICE W=SHARE  ;
?==============================================;
```

```
LIST DATA02 Q55801  Q55703 E55801  E55703 Q55901  Q55704
E55901  E55704 Q55902  Q557TOT E55902  Q558TOT Q55903  Q559TOT
E55903  Q560TOT Q55904  E557TOT E55904  E558TOT Q56001  E559TOT
E56001  E560TOT Q55701  QTOT   E55701  ETOT   Q55702  E55702;

? STEP (1A): CORRECTING QUANTITIES & EXPENDITURES FOR REPORTING
TIMES;
?==============================================================
===========;
? DIVIDE QXXXYY AND EXXXYY BY IDD TO PUT ON AVERAGE PER PURCHASING
OCCASSION;
?==============================================================
===========;
 DOT DATA02;  .=./IDD; ENDDOT;


? STEP (1B);
?===============================================;
? CALCULATING EXPENDITURES;
? NOTE THAT EXPENDITURES CAN BE ZERO;
? DEFINING THE EXOGENEOUS VARIABLES;
?===============================================;

? STEP (4) AND (9) MUST BE ADJUSTED DEPENDING ON THE NUMBER OF
VARIALBES;



? STEP (1C);
?===============================================;
? CALCULATING EXPENDITURES;
? NOTE THAT EXPENDITURES CAN BE ZERO;
? DEFINING THE EXOGENEOUS VARIABLES;
?===============================================;
? CONTROLLING ON ABSENCE OF DEMOGRAPHIC INFORMATION;
DDDEMO=(MNDINC>0) & (MNDHSZ>0) & (MNDAGF>0) &  (MNDCHD>0) &
(MNDEMF>0) &  (MNDEDF>0) &  (MNDSTA>0) &  (MNDADI>0) &  (MNDMSA >0)
;


? CONTROLLING OF IF CONSUMING ALL MEATS AT THE SAME PERIOD;
DDDMEAT=(E557TOT>0) & (E558TOT>0) & (E559TOT>0) & (E560TOT>0);


SELECT DDDEMO=1;

? HOUSEHOLD INCOME RANGES;
DINC=(MNDINC<=13) + ((MNDINC>=15) & (MNDINC<=19))*2 +
((MNDINC>=20) & (MNDINC<=24))*3 + (MNDINC>=25)*4;
DUMMY DINC;
```

```
VAR1= DINC1 - DINC4;
VAR2= DINC2 - DINC4;
VAR3= DINC3 - DINC4;

? HOUSEHOLD SIZE;
DHSZ=(MNDHSZ=1)*1 + (MNDHSZ=2)*2 + (MNDHSZ=3)*3 + (MNDHSZ>=4)*4;
DUMMY DHSZ;
VAR4=DHSZ1 - DHSZ4;
VAR5=DHSZ2 - DHSZ4;
VAR6=DHSZ3 - DHSZ4;

? AGE OF FEMALE HEAD OF HOUSEHOLD;
DAGF=( (MNDAGF>0) & (MNDAGF<=2))*1 + ((MNDAGF>=3) & (MNDAGF<=6))*2
+ (MNDAGF>=7)*3;
DUMMY DAGF;
VAR7=DAGF1 - DAGF3;
VAR8=DAGF2 - DAGF3;

? CHILDREN UNDER 18 IN HOUSEHOLD;
DCHD=(MNDCHD<=7);
DUMMY DCHD;
VAR9=DCHD1 - DCHD2;

? FEMALE EMPLOYMENT STATUS;
DEMF=((MNDEMF=9) )*1 + (MNDEMF=1)*2 + ( (MNDEMF>1) & (MNDEMF<9))*
3;
DUMMY DEMF;
VAR10=DEMF1-DEMF3;
VAR11=DEMF2-DEMF3;

? FEMALE EDUCATION;
DEDF=( (MNDEDF>0) & (MNDEDF<=3)) + ( (MNDEDF>=4) & (MNDEDF<=5))*2
+ (MNDEDF=6)*3;
DUMMY DEDF;
VAR12=DEDF1-DEDF3;
VAR13=DEDF2-DEDF3;


DSTA=(MNDSTA<30)*1 + ((MNDSTA>=30) & (MNDSTA<50))*2 +
((MNDSTA>=50) & (MNDSTA<80))*3 + (MNDSTA>=80)*4;
DUMMY DSTA;
VAR14=DSTA1-DSTA4;
VAR15=DSTA2-DSTA4;
VAR16=DSTA3-DSTA4;


? MARKET SIZE;
DMSA=(MNDMSA=9)*1 + (MNDMSA=1)*2 + ((MNDMSA>=3) & (MNDMSA<=8))*3;
DUMMY DMSA;
VAR17=DMSA1-DMSA3;
VAR18=DMSA2-DMSA3;
```

```
VAR19=PRCHL;
? SET ROOT=.50;
VAR20=SQRT(PROM);
VAR21=SQRT(LNA#PK);
VAR22=SQRT(LNA#PL + LNA#TK);

? SEASONALITY;
DUMMY QTR;
VAR23=QTR1-QTR4;
VAR24=QTR2-QTR4;
VAR25=QTR3-QTR4;

SELECT 1;


EX1=E557TOT;  ? EXPENDITURES ON BEEF;
EX2=E559TOT;  ? EXPENDITURES ON POULTRY;
EX3=E560TOT;  ? EXPENDITURES ON PORK;
EX4=E558TOT;  ? EXPENDITURES ON FISH;
EX = EX1 + EX2 + EX3 + EX4; ? TOTAL EXPENDITURES;
SELECT EX>0;
LEX=LOG(EX);
SELECT 1;
QT1=Q557TOT;  ? QUANTITY ON BEEF;
QT2=Q559TOT;  ? QUANTITY ON POULTRY;
QT3=Q560TOT;  ? QUANTITY ON PORK;
QT4=Q558TOT;  ? QUANTITY ON FISH;
QT=QT1 + QT2 + QT3 + QT4;   ? TOTAL QUANTITY;
SELECT QT>0;
LQT=LOG(QT);
SELECT 1;
DOT 1 2 3 4;  ? CREATING EXPENDITURE SHARES;
W. = EX./( (EX>0)*EX + (EX=0) ); WW.=0; ENDDOT;
? PRINT W1;
? PRINT W2;
? PRINT W3;
? PRINT W4;

HIST QT1;


DELETE E557TOT E559TOT E560TOT E558TOT Q557TOT Q559TOT Q560TOT
Q558TOT
DINC1-DINC4 DHSZ1-DHSZ4 DAGF1-DAGF3 DCHD1-DCHD2
DEMF1-DEMF3 DEDF1-DEDF3 DSTA1-DSTA4
DHSZ DAGF DCHD DEMF DEDF DSTA
PRCHL PROM LNA#PK LNA#PL LNA#TK;
COMPRESS;


? STEP (2);
```

```
?=============================================;
? CREATING AN AVERAGE PRICE FOR EACH MEAT BY    ;
? YEAR AND MONTH                                ;
? IF THE EXPENDITURES ARE ZERO THEN WE WILL USE ;
? THE AVERAGE PRICE IN THE MODEL                ;
?=============================================;
DO ZYR=1992 TO 1998;
DO ZQTRZ=3 TO 12 BY 3;
SELECT ( (YEAR=ZYR) & (QTR=ZQTRZ) );
IF @NOB=0; THEN; GOTO 100;
MSD(NOPRINT) EX1 EX2 EX3 EX4 QT1 QT2 QT3 QT4;
APR1= @SUM(1)/@SUM(5);  ? AVERAGE PRICE FOR BEEF;
APR2= @SUM(2)/@SUM(6);  ? AVERAGE PRICE FOR POULTRY;
APR3= @SUM(3)/@SUM(7);  ? AVERAGE PRICE FOR PORK;
APR4= @SUM(4)/@SUM(8);  ? AVERAGE PRICE FOR FISH;


DOT 1 2 3 4;
PR.=( EX. / ((EX.>0)*QT. + (EX.=0)) ) + (EX.= 0)*APR.;
LPR.=LOG(PR.); ENDDOT;         ? LOG OF PRICES;
100 ENDDO; ENDDO;
SELECT 1;
DOT APR1 APR2 APR3 APR4;  MSD .; ENDDOT;
DOT PR1 PR2 PR3 PR4;  MSD .; ENDDOT;

? MATRIX CELLS OF THE ESTIMATED COEFFICIENTS;
? K104     1 ;     ? K125   21 ;    ? K316   41 ;    ? K305   6 1  ;
? K406     81 ;
? K105     2 ;     ? K225   22 ;    ? K215   42 ;    ? K204   6 2  ;
? K407     82 ;
? K106     3 ;     ? K325   23 ;    ? K315   43 ;    ? K304   6 3  ;
? K408     83 ;
? K107     4 ;     ? K224   24 ;    ? K214   44 ;    ? AG13   6 4  ;
? K410     84 ;
? K108     5 ;     ? K324   25 ;    ? K314   45 ;    ? AG23   6 5  ;
? K411     85 ;
? K110     6 ;     ? K223   26 ;    ? K213   46 ;    ? AG33   6 6  ;
? K412     86 ;
? K111     7 ;     ? K323   27 ;    ? K313   47 ;    ? AG12   6 7  ;
? K413     87 ;
? K112     8 ;     ? K222   28 ;    ? K212   48 ;    ? AG22   6 8  ;
? K414     88 ;
? K113     9 ;     ? K322   29 ;    ? K312   49 ;    ? AG11   6 9  ;
? K415     89 ;
? K114     10 ;    ? K221   30 ;    ? K211   50 ;    ? A1     7 0  ;
? K416     90 ;
? K115     11 ;    ? K321   31 ;    ? K311   51 ;    ? A2     7 1  ;
? K417     91 ;
? K116     12 ;    ? K220   32 ;    ? K210   52 ;    ? A3     7 2  ;
? K418     92 ;
? K117     13 ;    ? K320   33 ;    ? K310   53 ;    ? B1     7 3  ;
```

```
? K419      93 ;
? K118      14 ;    ? K219   34 ;    ? K208   54 ;    ? B2     74 ;
? K420      94 ;
? K119      15 ;    ? K319   35 ;    ? K308   55 ;    ? B3     75 ;
? K421      95 ;
? K120      16 ;    ? K218   36 ;    ? K207   56 ;    ? A4     76 ;
? K422      96 ;
? K121      17 ;    ? K318   37 ;    ? K307   57 ;    ? B4     77 ;
? K423      97 ;
? K122      18 ;    ? K217   38 ;    ? K206   58 ;    ? AG44   78 ;
? K424      98 ;
? K123      19 ;    ? K317   39 ;    ? K306   59 ;    ? K404   79 ;
? K425      99 ;
? K124      20 ;    ? K216   40 ;    ? K205   60 ;    ? K405   80 ;

? AIDS MODEL ESTIMATES FOR THE FOUR INCOME GROUPS WITH THE ORDER
ABOVE;
READ(NROW=99,NCOL=4) AIDS_EST;
-0.00566  -0.06969  -0.03775  -0.02996
-0.00144  0.00407  0.00252  -0.01791
0.00362  0.02766  0.01264  0.02914
0.02326  0.01849  0.00325  -0.00178
0.00641  0.00203  -0.00275  0.00105
0.00080  -0.00145  -0.01821  -0.00591
-0.00807  -0.00428  0.01776  -0.01403
0.03847  0.03944  0.02071  0.01541
0.00510  0.00772  -0.01101  0.00810
-0.03632  -0.03408  -0.03559  -0.02644
0.00189  -0.00244  0.00978  -0.00444
0.00456  0.01302  0.00356  0.03191
0.00767  0.01533  0.03010  -0.05973
-0.00306  0.01083  -0.00404  0.08382
-0.18001  -0.13713  0.02606  -0.26413
0.00904  0.00193  -0.01154  0.00557
0.00003  -0.00011  0.00066  0.00020
0.00092  0.00029  0.00078  0.00082
0.00913  -0.00130  -0.00776  -0.00488
0.00996  0.01769  0.01340  0.01568
0.02462  0.02793  0.03710  0.02168
-0.01680  -0.00799  -0.01803  -0.00660
-0.00892  -0.01428  -0.01379  -0.02751
-0.01512  -0.01167  -0.01549  -0.02801
0.00464  -0.00114  0.00869  0.00302
-0.01104  -0.01432  -0.01021  -0.00929
-0.01184  -0.00657  -0.01378  0.01599
-0.00022  0.00025  -0.00007  -0.00029
-0.00047  -0.00053  -0.00008  -0.00094
-0.00034  0.00002  -0.00017  -0.00009
-0.00001  0.00005  -0.00026  0.00030
-0.00821  -0.00824  0.00795  -0.00175
-0.00205  0.00332  -0.00849  0.02414
```

-0.02466	0.07547	0.10993	-0.03841
0.26382	0.07253	0.15436	0.01739
-0.01049	-0.00882	-0.00763	-0.05970
0.01262	-0.00328	0.01210	-0.01115
-0.00017	-0.01378	-0.00898	0.03557
0.00571	0.01216	-0.00294	0.02537
0.01052	-0.00833	-0.00121	-0.02483
-0.00573	-0.00569	-0.00257	-0.01626
-0.01721	-0.02173	-0.02318	-0.00073
0.03304	0.03283	0.02772	0.03868
0.02366	0.03120	0.03255	0.02417
-0.00438	-0.01235	-0.00014	-0.01324
-0.00420	0.00278	0.01738	-0.00690
-0.00221	0.00018	-0.00510	0.00042
-0.06623	-0.05457	-0.04694	-0.04117
0.02870	0.02291	0.02314	0.02295
0.00768	0.00701	-0.00176	0.00523
-0.00359	0.00014	-0.00970	0.00977
0.00827	0.01586	0.02026	0.03326
-0.00567	-0.01015	-0.00260	-0.02129
0.00540	0.00282	0.00690	0.00664
-0.00793	0.00157	-0.00038	0.01159
-0.00245	0.00224	0.00253	0.02825
-0.02492	-0.02686	-0.02344	-0.04605
0.00506	-0.01627	0.02713	-0.00317
0.00499	0.00053	0.00812	-0.02759
-0.01305	-0.01142	0.00428	0.01112
0.01134	0.00852	0.00422	-0.01303
-0.01204	0.02608	-0.06592	-0.02821
-0.00080	0.00694	-0.01721	0.05415
0.02595	0.01409	-0.02937	-0.04148
-0.02024	-0.03115	-0.03471	-0.03397
0.00035	0.02578	0.08676	0.11930
-0.01758	-0.01668	-0.02295	-0.02617
0.02585	0.04377	0.06503	0.07432
-0.02265	0.00771	0.09070	0.14611
0.38160	0.43677	0.26528	0.35915
0.54942	0.45400	0.44550	0.61648
0.00229	0.12295	0.08896	0.14337
0.00136	-0.00079	0.01826	0.03158
-0.05419	-0.05528	-0.07206	-0.06534
0.02577	0.01768	0.01528	0.02053
0.06669	-0.01372	0.20026	-0.11900
0.02706	0.03839	0.03852	0.01323
-0.02020	0.00977	0.06844	0.13649
0.01850	0.03666	0.12089	0.00402
0.00316	-0.00116	-0.01103	0.01982
-0.01367	-0.01192	-0.04789	0.00162
0.00411	0.00614	0.01765	0.01959
-0.00387	-0.00642	-0.00377	-0.01928
-0.00340	-0.00425	0.00055	-0.00606

```
0.00398  -0.00286  -0.00631  -0.00098
-0.00094  -0.00778  0.00309  0.00281
0.00131  -0.01068  -0.00127  -0.00161
0.01703  0.01523  0.00318  0.01550
-0.01772  -0.00867  -0.01432  -0.03350
-0.00935  0.00101  0.00022  0.00918
-0.01321  -0.01371  -0.01819  -0.00122
0.00093  0.00127  -0.00043  -0.01298
-0.05915  -0.01086  -0.29036  0.28516
0.00121  0.00299  0.01208  -0.02796
0.00032  0.00004  -0.00023  -0.00042
-0.00023  -0.00001  -0.00062  0.00041
0.01374  0.02219  0.03174  -0.00182
0.00053  -0.00488  -0.00660  0.00931
0.00110  -0.00566  -0.00529  0.01242

PRINT AIDS_EST;

LIST ZBETAZ
K104 K105 K106 K107 K108 K110 K111 K112 K113 K114 K115 K116 K117
K118 K119 K120
K121 K122 K123 K124 K125 K225 K325 K224 K324 K223 K323 K222 K322
K221 K321 K220
K320 K219 K319 K218 K318 K217 K317 K216 K316 K215 K315 K214 K314
K213 K313 K212
K312 K211 K311 K210 K310 K208 K308 K207 K307 K206 K306 K205 K305
K204 K304 AG13
AG23 AG33 AG12 AG22 AG11 A1 A2 A3 B1 B2 B3 A4 B4 AG44 K404 K405 K406
K407 K408
K410 K411 K412 K413 K414 K415 K416 K417 K418 K419 K420 K421 K422
K423 K424 K425;




? STEP (3)
?==============================================;
?  SETTING DEMOGRAPHIC SIMULATION VALUES        ;
?==============================================;
SET ZROW=25; ? NUMBER OF SIMULATIONS;
? HOUSEHOLD SIZE 4 5 6;
? AGE OF FEMALE HEAD OF HOUSEHOLD 7 8;
? FEMALE EMPLOYMENT STATUS 10 11;
? FEMALE EDUCATION 12 13;
? REGIONS 14 15 16;
? MARKET SIZE 17 18;
? SEASONS 23 24 25;
? COLUMNS FOR THE DEMOGRPAHI VARIABLES;
?  0  0  0  0  0  1  1  1  1  1  1  1  1  1  2  2  2;
?  4  5  6  7  9  0  1  2  3  4  5  6  7  8  3  4  5;
```

```
READ(NROW=ZROW, NCOL=17) AIDS_DEMO;
   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
   1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
   0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
   0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  -1 -1 -1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
   0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0
   0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0
   0  0  0 -1 -1  0  0  0  0  0  0  0  0  0  0  0  0
   0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0
   0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0
   0  0  0  0  0 -1 -1  0  0  0  0  0  0  0  0  0  0
   0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
   0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0
   0  0  0  0  0  0  0 -1 -1  0  0  0  0  0  0  0  0
   0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0
   0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0
   0  0  0  0  0  0  0  0  0 -1 -1 -1  0  0  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  0 -1 -1  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0
   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1
   0  0  0  0  0  0  0  0  0  0  0  0  0  0 -1 -1 -1

PRINT AIDS_DEMO;

? CREATING THE DEMOGRAPHIC VALUES FROM THE MATRIX SIMULATIONS;
SMPL 1,ZROW;
UNMAKE AIDS_DEMO MVAR4 MVAR5 MVAR6 MVAR7  MVAR8   MVAR10  MVAR11
MVAR12
  MVAR13 MVAR14  MVAR15  MVAR16 MVAR17 MVAR18
  MVAR23 MVAR24  MVAR25;

SET MLPR1=0;     SET MLPR2=0;  SET MVAR20=0;  SET MVAR21=0;
SET MLPR3=0;      SET MLPR4=0;  SET MVAR22=0;  SET LMEX=0;    SET
MVAR19=0;
SET ELAST11=0; SET ELAST12=0; SET ELAST13=0; SET ELAST14=0;
SET ELAST21=0; SET ELAST22=0; SET ELAST23=0; SET ELAST24=0;
SET ELAST31=0; SET ELAST32=0; SET ELAST33=0; SET ELAST34=0;
SET ELAST41=0; SET ELAST42=0; SET ELAST43=0; SET ELAST44=0;
SET IELAST1=0; SET IELAST2=0;     SET IELAST3=0; SET IELAST4=0;
SET SHELAST1=0; SET SHELAST2=0; SET SHELAST3=0; SET SHELAST4=0;
SET SHPELAST11=0;  SHPELAST12=0; SHPELAST13=0; SHPELAST14=0;
SET SHPELAST21=0;  SHPELAST22=0; SHPELAST23=0; SHPELAST24=0;
SET SHPELAST31=0;  SHPELAST32=0; SHPELAST33=0; SHPELAST34=0;
SET SHPELAST41=0;  SHPELAST42=0; SHPELAST43=0; SHPELAST44=0;
SET CELAST11=0; SET CELAST12=0; SET CELAST13=0; SET CELAST14=0;
```

```
SET CELAST21=0; SET CELAST22=0; SET CELAST23=0; SET CELAST24=0;

SET CELAST31=0; SET CELAST32=0; SET CELAST33=0; SET CELAST34=0;

SET CELAST41=0; SET CELAST42=0; SET CELAST43=0; SET CELAST44=0;

   PRINT AIDS_DEMO;


?==============================================;
? SIMULATION PROCEDURE                         ;
?==============================================;

PROC AIDS_SIM ;
? DO J=1 TO 4;
PRINT J;
SMPL 1,NOB;
SET UPPER=50;    ? REMOVING POTENTIAL OUTLIERS IN TERMS OF POUNDS;
DUPPER=(QT1<=UPPER) & (QT2<=UPPER) & (QT3<=UPPER) & (QT4<=UPPER);
SELECT (EX>0) & (YEAR<=1997) & (DDDEMO=1) & (DDDMEAT>=0) &(DINC=J)
& (DUPPER=1);
MSD(PRINT) PR1 PR2 PR3 PR4 EX PRCHL PROM LNA#PK LNA#PL LNA#TK;
SMPL 1,ZROW;
SET I=0;  DOT ZBETAZ;  SET I=I+1;  SET .=AIDS_EST(I,J);   ENDDOT;
SET MLPR1=LOG(@MEAN(1));  SET MLPR2=LOG(@MEAN(2));
SET  MLPR3=LOG(@MEAN(3));      SET  MLPR4=LOG(@MEAN(4));      SET
LMEX=LOG(@MEAN(5));
SET  MVAR19=@MEAN(6);         SET  MVAR20=SQRT(@MEAN(7));     SET
MVAR21=SQRT(@MEAN(8));
SET MVAR22= SQRT (@MEAN(9)+@MEAN(10));
SET AG14=-AG11-AG12-AG13;
SET AG24=(-AG12-AG22-AG23);
SET AG34=(-AG13-AG23-AG33);
? SET AG44=(-AG14-AG24-AG34);
PRINT AG14;
PRINT AG24;
PRINT AG34;
PRINT AG44;
PRINT A1;
PRINT B1;
PRINT LMEX;
PRINT MLPR1;
PRINT MVAR19;
PRINT MVAR20;
PRINT MVAR21;
PRINT MVAR22;

ZG11= AG11*MLPR1 + AG12*MLPR2 + AG13*MLPR3 + AG14*MLPR4;
ZG12= AG12*MLPR1 + AG22*MLPR2 + AG23*MLPR3 + AG24*MLPR4;
ZG13= AG13*MLPR1 + AG23*MLPR2 + AG33*MLPR3 + AG34*MLPR4;
```

```
ZG14= AG14*MLPR1 + AG24*MLPR2 + AG34*MLPR3 + AG44*MLPR4;
PRINT ZG11 ZG12 ZG13 ZG14;


 ZXG1= K104*MVAR4 + K105*MVAR5 + K106*MVAR6 +
  K107*MVAR7 + K108*MVAR8 + K110*MVAR10 + K111*MVAR11 + K112*MVAR12
+  K113*MVAR13  +  K114*MVAR14  +  K115*MVAR15  +  K116*MVAR16  +
K117*MVAR17 + K118*MVAR18 +
  K119*MVAR19 + K120*MVAR20 + K121*MVAR21 + K122*MVAR22 +
  K123*MVAR23 + K124*MVAR24 + K125*MVAR25 ;

 ZXG2= K204*MVAR4 + K205*MVAR5 + K206*MVAR6 +
  K207*MVAR7 + K208*MVAR8 + K210*MVAR10 + K211*MVAR11 + K212*MVAR12
+  K213*MVAR13  +  K214*MVAR14  +  K215*MVAR15  +  K216*MVAR16  +
K217*MVAR17 + K218*MVAR18 +
  K219*MVAR19 + K220*MVAR20 + K221*MVAR21 + K222*MVAR22 +
  K223*MVAR23 + K224*MVAR24 + K225*MVAR25 ;

 ZXG3= K304*MVAR4 + K305*MVAR5 + K306*MVAR6 +
  K307*MVAR7 + K308*MVAR8 + K310*MVAR10 + K311*MVAR11 + K312*MVAR12
+  K313*MVAR13  +  K314*MVAR14  +  K315*MVAR15  +  K316*MVAR16  +
K317*MVAR17 + K318*MVAR18 + K319*MVAR19 + K320*MVAR20 + K321*MVAR21
+ K322*MVAR22 +
  K323*MVAR23 + K324*MVAR24 + K325*MVAR25 ;

 ZXG4= K404*MVAR4 + K405*MVAR5 + K406*MVAR6 +
  K407*MVAR7 + K408*MVAR8 + K410*MVAR10 + K411*MVAR11 + K412*MVAR12
+K413*MVAR13 + K414*MVAR14 + K415*MVAR15 + K416*MVAR16 + K417*MVAR17
+ K418*MVAR18 +
  K419*MVAR19 + K420*MVAR20 + K421*MVAR21 + K422*MVAR22 +
  K423*MVAR23 + K424*MVAR24 + K425*MVAR25;

PRINT ZXG1 ZXG2 ZXG3 ZXG4;

? PRICE INDEX;
 PPR1= ((A1+ ZXG1 )+(1/2)*(ZG11))*MLPR1;
 PPR2= ((A2+ ZXG2 )+(1/2)*(ZG12))*MLPR2;
 PPR3= ((A3+ ZXG3 )+(1/2)*(ZG13))*MLPR3;
 PPR4= ((A4+ ZXG4 )+(1/2)*(ZG14))*MLPR4;
 PRINT PPR1 PPR2 PPR3 PPR4;
 APPR= PPR1 + PPR2 + PPR3 + PPR4;

? EXPENDITURE EQUATIONS
 WW1=A1 + ZXG1 + ZG11 + B1*(LMEX-APPR);
 WW2=A2 + ZXG2 + ZG12 + B2*(LMEX-APPR);
 WW3=A3 + ZXG3 + ZG13 + B3*(LMEX-APPR);
 WW4=A4 + ZXG4 + ZG14 + B4*(LMEX-APPR);

    AVGP1=A1+ZXG1+ZG11;
    AVGP2=A2+ZXG2+ZG12;
```

```
    AVGP3=A3+ZXG3+ZG13;
    AVGP4=A4+ZXG4+ZG14;

?ELASTICITY FOR BEEF;
    ELAST11=(AG11-B1*AVGP1)/WW1-1;
    ELAST12=(AG12-B1*AVGP2)/WW1;
    ELAST13=(AG13-B1*AVGP3)/WW1;
    ELAST14=(AG14-B1*AVGP4)/WW1;

? ELASTICITY FOR POULTRY;
 ELAST21=(AG12-B2*AVGP1)/WW2;
 ELAST22=(AG22-B2*AVGP2)/WW2-1;
 ELAST23=(AG23-B2*AVGP3)/WW2;
 ELAST24=(AG24-B2*AVGP4)/WW2;

? ELASTICITY FOR PORK;
      ELAST31=(AG13-B3*AVGP1)/WW3;
      ELAST32=(AG23-B3*AVGP2)/WW3;
      ELAST33=(AG33-B3*AVGP3)/WW3-1;
      ELAST34=(AG34-B3*AVGP4)/WW3;

? ELASTICITY FOR FISH;
 ELAST41=(AG14-B4*AVGP1)/WW4;
 ELAST42=(AG24-B4*AVGP2)/WW4;
 ELAST43=(AG34-B4*AVGP3)/WW4;
 ELAST44=(AG44-B4*AVGP4)/WW4-1;

?INCOME ELASTICITY OF DEMAND;
 IELAST1=1+B1/WW1;
 IELAST2=1+B2/WW2;
 IELAST3=1+B3/WW3;
 IELAST4=1+B4/WW4;


 ?EXPENDITURE SHARE ELASTICITIES;
 SHELAST1=B1/WW1;
 SHELAST2=B2/WW2;
 SHELAST3=B3/WW3;
 SHELAST4=B4/WW4;

 SHPELAST11= (AG11-B1*AVGP1)/WW1;
 SHPELAST12= (AG12-B1*AVGP2)/WW1;
 SHPELAST13= (AG13-B1*AVGP3)/WW1;
 SHPELAST14= (AG14-B1*AVGP4)/WW1;

 SHPELAST21= (AG12-B2*AVGP1)/WW2;
 SHPELAST22=(AG22-B2*AVGP2)/WW2;
 SHPELAST23=(AG23-B2*AVGP3)/WW2;
 SHPELAST24=(AG24-B2*AVGP4)/WW2;

 SHPELAST31= (AG13-B3*AVGP1)/WW3;
```

```
SHPELAST32=(AG23-B3*AVGP2)/WW3;
SHPELAST33=(AG33-B3*AVGP3)/WW3;
SHPELAST34=(AG34-B3*AVGP4)/WW3;

SHPELAST41=(AG14-B4*AVGP1)/WW4;
SHPELAST42=(AG24-B4*AVGP2)/WW4;
SHPELAST43=(AG34-B4*AVGP3)/WW4;
SHPELAST44=(AG44-B4*AVGP4)/WW4;


?COMPENSATED ELASTICITIES FOR BEEF;
CELAST11=ELAST11+WW1*IELAST1;
CELAST12=ELAST12+WW2*IELAST1;
CELAST13=ELAST13+WW3*IELAST1;
CELAST14=ELAST14+WW4*IELAST1;

?COMPENSATED ELASTICITIES FOR POULTRY;
CELAST21=ELAST21+WW1*IELAST2;
CELAST22=ELAST22+WW2*IELAST2;
CELAST23=ELAST23+WW3*IELAST2;
CELAST24=ELAST24+WW4*IELAST2;

?COMPENSATED ELASTICITIES FOR PORK;
CELAST31=ELAST31+WW1*IELAST3;
CELAST32=ELAST32+WW2*IELAST3;
CELAST33=ELAST33+WW3*IELAST3;
CELAST34=ELAST34+WW4*IELAST3;

?COMPENSATED ELASTICITIES FOR FISH;
CELAST41=ELAST41+WW1*IELAST4;
CELAST42=ELAST42+WW2*IELAST4;
CELAST43=ELAST43+WW3*IELAST4;
CELAST44=ELAST44+WW4*IELAST4;

MSD ELAST11 ELAST12 ELAST13 ELAST14;
MSD ELAST21 ELAST22 ELAST23 ELAST24;
MSD ELAST31 ELAST32 ELAST33 ELAST34;
MSD ELAST41 ELAST42 ELAST43 ELAST44;
MSD IELAST1 IELAST2 IELAST3 IELAST4;
MSD SHELAST1 SHELAST2 SHELAST3 SHELAST4;
MSD SHPELAST11  SHPELAST12 SHPELAST13 SHPELAST14;
MSD SHPELAST21  SHPELAST22 SHPELAST23 SHPELAST24;
MSD SHPELAST31  SHPELAST32 SHPELAST33 SHPELAST34;
MSD SHPELAST41  SHPELAST42 SHPELAST43 SHPELAST44;
MSD CELAST11 CELAST12 CELAST13 CELAST14;
MSD CELAST21 CELAST22 CELAST23 CELAST24;
MSD CELAST31 CELAST32 CELAST33 CELAST34;
MSD CELAST41 CELAST42 CELAST43 CELAST44;
```

```
 ENDPROC;
? ENDDO;


?================================================;
? FIRST INCOME GROUP (J=1);
?================================================;
SET J=1;
AIDS_SIM;
PRINT WW1 WW2 WW3 WW4;
PRINT ELAST11 ELAST12 ELAST13 ELAST14;
PRINT ELAST21 ELAST22 ELAST23 ELAST24;
PRINT ELAST31 ELAST32 ELAST33 ELAST34;
PRINT ELAST41 ELAST42 ELAST43 ELAST44;
PRINT IELAST1 IELAST2 IELAST3 IELAST4;
PRINT SHELAST1 SHELAST2 SHELAST3 SHELAST4;
PRINT SHPELAST11  SHPELAST12 SHPELAST13 SHPELAST14;
PRINT SHPELAST21  SHPELAST22 SHPELAST23 SHPELAST24;
PRINT SHPELAST31  SHPELAST32 SHPELAST33 SHPELAST34;
PRINT SHPELAST41  SHPELAST42 SHPELAST43 SHPELAST44;
PRINT CELAST11 CELAST12 CELAST13 CELAST14;
PRINT CELAST21 CELAST22 CELAST23 CELAST24;
PRINT CELAST31 CELAST32 CELAST33 CELAST34;
PRINT CELAST41 CELAST42 CELAST43 CELAST44;

MMAKE SHARINC1 WW1 WW2 WW3 WW4 ELAST11 ELAST12 ELAST13 ELAST14
ELAST21 ELAST22 ELAST23 ELAST24 ELAST31 ELAST32 ELAST33 ELAST34
ELAST41 ELAST42 ELAST43 ELAST44 IELAST1 IELAST2 IELAST3 IELAST4
CELAST11 CELAST12 CELAST13 CELAST14 CELAST21 CELAST22 CELAST23
CELAST24
CELAST31 CELAST32 CELAST33 CELAST34 CELAST41 CELAST42 CELAST43
CELAST44;

SET J=2;
AIDS_SIM;
PRINT WW1 WW2 WW3 WW4;
PRINT ELAST11 ELAST12 ELAST13 ELAST14;
PRINT ELAST21 ELAST22 ELAST23 ELAST24;
PRINT ELAST31 ELAST32 ELAST33 ELAST34;
PRINT ELAST41 ELAST42 ELAST43 ELAST44;
PRINT IELAST1 IELAST2 IELAST3 IELAST4;
PRINT SHELAST1 SHELAST2 SHELAST3 SHELAST4;
PRINT SHPELAST11  SHPELAST12 SHPELAST13 SHPELAST14;
PRINT SHPELAST21  SHPELAST22 SHPELAST23 SHPELAST24;
PRINT SHPELAST31  SHPELAST32 SHPELAST33 SHPELAST34;
PRINT SHPELAST41  SHPELAST42 SHPELAST43 SHPELAST44;
PRINT CELAST11 CELAST12 CELAST13 CELAST14;
PRINT CELAST21 CELAST22 CELAST23 CELAST24;
PRINT CELAST31 CELAST32 CELAST33 CELAST34;
PRINT CELAST41 CELAST42 CELAST43 CELAST44;
```

```
MMAKE SHARINC2 WW1 WW2 WW3 WW4 ELAST11 ELAST12 ELAST13 ELAST14
ELAST21 ELAST22 ELAST23 ELAST24 ELAST31 ELAST32 ELAST33 ELAST34
ELAST41 ELAST42 ELAST43 ELAST44 IELAST1 IELAST2 IELAST3 IELAST4
CELAST11 CELAST12 CELAST13 CELAST14 CELAST21 CELAST22 CELAST23
CELAST24
CELAST31 CELAST32 CELAST33 CELAST34 CELAST41 CELAST42 CELAST43
CELAST44;

SET J=3;
AIDS_SIM;
PRINT WW1 WW2 WW3 WW4;
PRINT ELAST11 ELAST12 ELAST13 ELAST14;
PRINT ELAST21 ELAST22 ELAST23 ELAST24;
PRINT ELAST31 ELAST32 ELAST33 ELAST34;
PRINT ELAST41 ELAST42 ELAST43 ELAST44;
PRINT IELAST1 IELAST2 IELAST3 IELAST4;
PRINT SHELAST1 SHELAST2 SHELAST3 SHELAST4;
PRINT SHPELAST11  SHPELAST12 SHPELAST13 SHPELAST14;
PRINT SHPELAST21  SHPELAST22 SHPELAST23 SHPELAST24;
PRINT SHPELAST31  SHPELAST32 SHPELAST33 SHPELAST34;
PRINT SHPELAST41  SHPELAST42 SHPELAST43 SHPELAST44;
PRINT CELAST11 CELAST12 CELAST13 CELAST14;
PRINT CELAST21 CELAST22 CELAST23 CELAST24;
PRINT CELAST31 CELAST32 CELAST33 CELAST34;
PRINT CELAST41 CELAST42 CELAST43 CELAST44;


MMAKE SHARINC3 WW1 WW2 WW3 WW4 ELAST11 ELAST12 ELAST13 ELAST14
ELAST21 ELAST22 ELAST23 ELAST24 ELAST31 ELAST32 ELAST33 ELAST34
ELAST41 ELAST42 ELAST43 ELAST44 IELAST1 IELAST2 IELAST3 IELAST4
CELAST11 CELAST12 CELAST13 CELAST14 CELAST21 CELAST22 CELAST23
CELAST24
CELAST31 CELAST32 CELAST33 CELAST34 CELAST41 CELAST42 CELAST43
CELAST44;

SET J=4;
AIDS_SIM;
PRINT WW1 WW2 WW3 WW4;
PRINT ELAST11 ELAST12 ELAST13 ELAST14;
PRINT ELAST21 ELAST22 ELAST23 ELAST24;
PRINT ELAST31 ELAST32 ELAST33 ELAST34;
PRINT ELAST41 ELAST42 ELAST43 ELAST44;
PRINT IELAST1 IELAST2 IELAST3 IELAST4;
PRINT SHELAST1 SHELAST2 SHELAST3 SHELAST4;
PRINT SHPELAST11  SHPELAST12 SHPELAST13 SHPELAST14;
PRINT SHPELAST21  SHPELAST22 SHPELAST23 SHPELAST24;
PRINT SHPELAST31  SHPELAST32 SHPELAST33 SHPELAST34;
PRINT SHPELAST41  SHPELAST42 SHPELAST43 SHPELAST44;
PRINT CELAST11 CELAST12 CELAST13 CELAST14;
PRINT CELAST21 CELAST22 CELAST23 CELAST24;
PRINT CELAST31 CELAST32 CELAST33 CELAST34;
```

```
PRINT CELAST41 CELAST42 CELAST43 CELAST44;

MMAKE SHARINC4 WW1 WW2 WW3 WW4 ELAST11 ELAST12 ELAST13 ELAST14
ELAST21 ELAST22 ELAST23 ELAST24 ELAST31 ELAST32 ELAST33 ELAST34
ELAST41 ELAST42 ELAST43 ELAST44 IELAST1 IELAST2 IELAST3 IELAST4
CELAST11 CELAST12 CELAST13 CELAST14 CELAST21 CELAST22 CELAST23
CELAST24
CELAST31 CELAST32 CELAST33 CELAST34 CELAST41 CELAST42 CELAST43
CELAST44;

MMAKE SIMINC SHARINC1 SHARINC2 SHARINC3 SHARINC4;
WRITE(FORMAT=LOTUS,FILE='D:\ZBEEF\ZMEATDMD\AIDSTSP\SIM01.WK1')
SIMINC;

END;
```

APPENDIX C
BUDGET SHARES FOR THE FOUR PRODUCTS

Table C.1: Budget shares for the four meat products across different exogenous variables (income level under $25,000).

		Beef	Poultry	Pork	Fish
average consumer		39.89%	30.12%	20.67%	9.322%
Household size(number of people)	1	39.32%	29.00%	20.54%	11.13%
	2	39.74%	28.86%	21.78%	9.62%
	3	40.25%	30.57%	21.19%	7.98%
	4 plus	40.24%	32.05%	19.15%	8.56%
Age of female (years)	29 and under	42.21%	29.89%	18.16%	9.72%
	30 to 49	40.53%	30.63%	19.88%	8.95%
	over 50	36.92%	29.83%	23.95%	9.30%
Female employment level (hours)	unemployed	39.97%	30.91%	20.11%	8.00%
	0 to 30	39.08%	30.88%	20.31%	9.72%
	over 30	40.61%	28.56%	21.57%	9.25%
Female education level	high school	43.73%	23.65%	23.46%	9.15%
	college	40.40%	29.71%	20.44%	9.45%
	post college graduate	35.53%	36.99%	18.10%	9.37%
Census region	east	36.25%	32.48%	20.23%	11.0%
	central	40.08%	28.38%	23.98%	7.56%
	south	40.34%	31.11%	20.12%	8.42%
	west	42.87%	28.49%	18.34%	10.29%
Market size(number of people)	0 to 49,999	40.65%	30.06%	21.26%	8.02%
	50,000 to 249,999	39.58%	29.10%	21.91%	9.40%
	over 250,000	39.42%	31.20%	18.83%	10.54%
Seasonality (quarters)	January-March	40.80%	29.08%	19.45%	10.66%
	April-June	40.88%	28.64%	21.11%	9.36%
	July-September	42.35%	28.48%	19.75%	9.41%
	October-Dec.	35.52%	34.26%	22.35%	7.86%

Table C.2: Budget shares for the four meat products across different exogenous variables (income level from $25,000 to $49,999)

		Beef	Poultry	Pork	Fish
average consumer		37.48%	30.80%	19.83%	11.89%
Household size(number of people)	1	30.51%	33.47%	20.50%	15.51%
	2	37.89%	29.68%	20.67%	11.76%
	3	40.25%	29.17%	19.88%	10.70%
	4 plus	41.28%	30.87%	18.26%	9.59%
Age of female (years)	29 and under	39.33%	31.03%	17.14%	12.49%
	30 to 49	37.68%	31.05%	20.00%	11.26%
	over 50	35.43%	30.30%	22.35%	11.91%
Female employment level (hours)	unemployed	37.34%	32.33%	18.83%	11.50%
	0 to 30	37.05%	31.47%	19.85%	11.62%
	over 30	38.06%	28.58%	20.81%	12.55%
Female education level	high school	41.43%	25.44%	22.09%	11.04%
	college	38.25%	31.03%	19.86%	10.85%
	post college graduate	32.77%	35.92%	17.54%	13.77%
Census region	east	34.07%	33.90%	18.60%	13.42%
	central	37.24%	28.64%	23.11%	11.01%
	south	38.78%	29.99%	19.25%	11.97%
	west	39.83%	30.66%	18.36%	11.15%
Market size(number of people)	0 to 49,999	39.01%	29.40%	21.05%	10.53%
	50,000 to 249,999	38.57%	29.94%	19.49%	12.00%
	over 250,000	34.87%	33.05%	18.94%	13.14%
Seasonality (quarters)	January-March	37.35%	29.47%	19.14%	14.03%
	April-June	39.25%	29.64%	19.71%	11.39%
	July-September	40.28%	30.00%	18.40%	11.32%
	October-Dec.	33.05%	34.08%	22.07%	10.80%

Table C.3: Budget shares for the four meat products across different exogenous variables (income level from $50,000 to $74,999)

		Beef	Poultry	Pork	Fish
Average consumer		40.89%	26.42%	19.04%	13.75%
Household size(number of people)	1	36.94%	20.51%	17.17%	25.48%
	2	41.15%	26.80%	19.47%	12.68%
	3	42.22%	28.87%	19.91%	9.11%
	4 plus	43.23%	29.53%	19.60%	7.74%
Age of female (years)	29 and under	41.19%	26.74%	16.68%	15.48%
	30 to 49	40.62%	27.08%	19.01%	13.39%
	over 50	40.84%	25.45%	21.43%	12.38%
Female employment level (hours)	unemployed	39.08%	28.39%	18.79%	13.84%
	0 to 30	42.67%	26.23%	18.07%	13.13%
	over 30	40.91%	24.65%	20.25%	14.29%
Female education level	high school	42.92%	21.88%	21.32%	13.98%
	college	39.80%	28.11%	18.54%	13.65%
	post college graduate	39.94%	29.29%	17.25%	13.62%
Census region	east	37.35%	29.60%	19.04%	14.11%
	central	41.86%	24.11%	21.81%	12.32%
	south	41.24%	26.31%	18.78%	13.77%
	west	43.09%	25.68%	16.52%	14.81%
Market size(number of people)	0 to 49,999	43.91%	25.48%	18.75%	11.96%
	50,000 to 249,999	40.48%	25.68%	20.24%	13.70%
	over 250,000	38.27%	28.11%	18.12%	15.60%
Seasonality (quarters)	January-March	40.07%	25.56%	17.63%	16.84%
	April-June	42.22%	24.89%	19.90%	13.08%
	July-September	44.59%	24.66%	17.65%	13.20%
	October-Dec.	36.66%	30.59%	20.97%	11.88%

Table C.4: Budget shares for the four meat products across different exogenous variables (income level over $75,000).

		Beef	Poultry	Pork	Fish
Average consumer		36.72%	30.20%	19.88%	13.14%
Household size(number of people)	1	33.70%	27.45%	25.27%	13.53%
	2	34.91%	31.36%	18.56%	15.11%
	3	39.62%	29.91%	17.11%	13.29%
	4 plus	38.67%	32.08%	18.57%	10.62%
Age of female (years)	29 and under	36.54%	33.04%	15.27%	15.09%
	30 to 49	36.88%	30.76%	21.07%	11.23%
	over 50	36.76%	26.79%	23.30%	13.09%
Female employment level (hours)	unemployed	36.19%	33.42%	17.79%	12.55%
	0 to 30	35.33%	30.70%	20.86%	13.05%
	over 30	38.65%	26.48%	20.99%	13.82%
Female education level	high school	38.21%	26.20%	22.14%	13.40%
	college	37.53%	29.52%	19.92%	12.97%
	post college graduate	34.44%	34.87%	17.58%	13.05%
Census region	east	34.08%	32.61%	18.56%	14.69%
	central	36.35%	29.98%	23.79%	9.82%
	south	39.86%	27.83%	18.22%	14.03%
	west	36.61%	30.37%	18.95%	14.01%
Market size(number of people)	0 to 49,999	30.81%	33.63%	22.45%	13.04%
	50,000 to 249,999	45.04%	24.36%	18.72%	11.81%
	over 250,000	34.32%	32.60%	18.46%	14.56%
Seasonality (quarters)	January-March	36.23%	29.28%	21.48%	12.95%
	April-June	38.24%	27.51%	20.15%	14.05%
	July-September	38.85%	29.62%	17.10%	14.36%
	October-Dec.	33.58%	34.38%	20.79%	11.19%

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Sara Medina was born on August 3, 1972, in Porto, Portugal. In July of 1995 she completed a five year degree in food engineering from Escola Superior de Biotecnologia (College of Biotechnology) in Porto, Portugal. During the first semester of the final year of undergraduate studies in food engineering, she had the opportunity of going to the Nestle Research Center located in Lausanne (Switzerland) for a period of six months. There she was involved in a research project entitled "Production and Characterization of Egg White Fractions." In March of 1997 she completed the European Masters Degree in Food Studies. This was an 18 months program in management, food science, technology and engineering offered jointly by Escola Superior de Biotecnologia (College of Biotechnology), Portugal; University of Cork, Ireland; University of Reading, England; ENSIA, France, and University of Lund, Sweden. The course work was divided into five periods, each of two months duration consisting of three to four study modules supplemented by seminars and industrial visits. The research thesis entitled <u>An Economic Analysis of Best Management Practices (BMPs) for Potatoes in the Hastings Producing Area of North Florida</u> was completed in the University of Florida (Food and Resource Economics Department) under the supervision of Dr. John VanSickle. In the summer of 1997, she started a doctoral program at the Food and Resource Economics Department, University of Florida. Her major areas of research are in marketing and econometrics. During her doctoral research, she represented the University of Florida in international meetings in the U.S., Italy, Uruguay and Portugal. She was also president of the Graduate Student Organization in her department from August 1998 through July 1999. She has a paper together with Dr. Ronald Ward, published in the <u>International Food and Agribusiness Management Review</u> entitled "A Model of Retail Outlet Selection for Beef."

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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